Utah Skier Visit Analysis

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I. Introduction

Many of Utah's ski resorts are located on lands managed by the U.S. Forest Service. While these resorts are privately operated enterprises, the Forest Service regulates certain aspects of their operations because they are located, at least partially, on National Forest System lands. The Forest Service is currently reviewing proposals from three ski resorts in the Cottonwood Canyons: Brighton, Snowbird and Solitude. This review is required by the National Environmental Policy Act (NEPA) and will analyze and document potential impacts of various alternatives in an Environmental Impact Statement (EIS). The EIS will analyze the resorts' proposed actions for mountain improvements, known as the proposed action; a no action alternative, in which the resorts' operations on National Forest System lands do not change; and a reasonable range of other action alternatives, created to address issues and concerns about the biological, physical, and human environments. The Forest Supervisor for the Wasatch-Cache National Forest will issue a Record of Decision (ROD) for each resort upon completion of each resort's EIS.

To facilitate a coordinated assessment of the likely visitation at each of the resorts under the proposed action and the no action alternatives, the Forest Service contracted with the Governor's Office of Planning and Budget (GOPB) to conduct the Utah Skier Visit Analysis. Because the three Cottonwood Canyons resorts operate in the broader Utah ski market, GOPB's approach is a two step process. In the first step, total skier visits statewide are forecast. In the second step, the skier visit forecasts are allocated to each of the 14 resorts in the state. GOPB's approach assures that the forecasts used in each of the Cottonwood Canyons resorts are consistent with each other and consistent with expectations for the broader Utah ski market.

GOPB's skier visit analysis is organized as follows. Section II overviews skiing in Utah and the U.S. Section III discusses the determinants of skiing. Section IV presents the method used to forecast skier visits statewide, while Section V presents the method used to allocate these forecasts to the individual resorts. Section VI presents the results. Section VII concludes. An appendix discusses previous rounds of skier visit forecasts.

This current analysis is the fourth round of Utah skier visit analyses. The first round was conducted by the Forest Service in the 1985 Wasatch-Cache Forest Plan. The second and third rounds were conducted by GOPB. The second round was part of the 1988 Wasatch Canyons Master Plan effort while the third round was part of the 1991 Brighton EIS. The appendix contains an evaluation of the accuracy of the three rounds of forecasts.

II. Overview of Skiing in Utah and the U.S.

Skiing has become phenomenally popular in the last half century. From a few thousand before World War II, skier visits nationwide have grown to almost 55 million per year during the 1990s. For the past two decades or so, however, there has been little growth in the national ski market. As Figure 1 depicts, skier visits nationwide fell from just over 50 million in 1979 to under 40 million in 1981, and have been in the 50 million to 55 million range since then. But Utah's share of the national market has increased from about 4.5 percent in the early 1980s to around 5.5 percent today. In other words, although the national market was flat, Utah still managed to increase its share a full percentage point, or over 20 percent.

As Figure 2 depicts, skiing in Utah has been on a steady growth path the last four decades. From a couple hundred thousand during the early 1960s, skier visits in Utah grew to over 3 million by the late 1990s. While the overall Utah ski market has been growing, as Figure 3 depicts, the structure of the market has been changing. Skiing in Utah has switched from a predominantly resident day outing activity to more of a destination week long vacation.

During the early 1960s, skiing in Utah was essentially home grown in the sense that most people skiing here also lived here. Amenities at the resorts during this period were scarce and spartan. With the construction of Snowbird in the early 1970s and the expansion of Park City, skiing in Utah took on more of a destination flavor. Upscale restaurants and bars became part of the ski resorts' attractions, world class hotels and ski lodge complexes were constructed near the resorts, and the resorts themselves became much more tourist oriented. With the exception of a few areas that still cater almost exclusively to locals, Utah's ski resorts today are among the finest entertainment centers in the world, combining outdoor recreation opportunities with a variety of eating, drinking, nightlife and daytime amusement activities.

Throughout most of the 1960s, as figure 3 depicts, residents made well over 80 percent of skier visits. During the 1970s and early 1980s, as the ski resorts made the transition from the small time to the big time, the numbers of resident skiers and destination skiers were approximately the same. By the 1990s, destination tourists--people traveling long distances for an extended vacation experience--made 55 percent to 60 percent of skier visits. The growth in destination skiers is even more astounding than the increase in their market share. In the early 1960s, there were 20,000 to 30,000 destination skier visits per year in Utah. By the late 1990s, the number of destination skier visits had increased almost 100 times to about 1.7 million.

III. Discussion of Skier Visit Determinants

People ski for a number of reasons, which are difficult to measure. Fundamentally,

people ski because they want to and because it is possible. People want to ski because they have leisure time and because they have a taste for winter recreation. Skiing is possible because of snow and ski resorts and because it is affordable. A brief discussion of the general determinants of skiing in combination with an analysis of some of the variables associated with skier visits will provide background for the technical discussion of forecasting skier visits.

III.1 General Determinants of Skier Visits

The general determinants of skier visits are as follows.

1. Snow;
2. Skiing age population;
3. Income or economic activity;
4. Ski ticket price;
5. Distance of resort from where skiers live or stay;
6. Cost of travel;
7. Ski area lift capacity;
8. Recreation tastes;
9. Accommodations;
10. Amenities; and
11. Marketing.

For the most part, it is fairly obvious how these determinants generate skier visits, but a brief discussion will make the concepts clear. Snow is the most obvious requirement for skiing and plays an important role in GOPB's skier visit forecasts. The growth of the U.S. skiing age population has been a major historical determinant in the growth of skiing since the end of World War II. The growth in income has resulted in a wealthy society capable of supporting a recreational pastime such as skiing. Relative ticket prices cause some high price resorts to attract a wealthier destination tourist crowd, while low price resorts attract a more frugal resident crowd. The farther distant a resort is from where skiers live or stay the less likely they are to visit. The more it costs to travel the less likely people are to travel to ski. Ski lifts are required if skiing is to occur at a given resort. While the direction of causation is unclear, the increase in skier visits and ski lift capacity in Utah are closely associated. Consumer tastes have changed over the past several decades so that the demand for winter recreation such as skiing has increased. The transformation of ski resort accommodations and amenities from spartan to luxurious was necessary for Utah skiing to compete with other regions providing similar recreation opportunities. Marketing keeps the public aware that skiing in Utah is as good as it gets.

III.2 Variables Associated with Skier Visits

The most illuminating variables in terms of forecasting skier visits include population, lift capacity and snow.

III.2.1 Skiing Age Population

Skiing age population has been a major determinant of skier visits since the end of World War II. An increase in population, an increase in leisure time, and an increase in the taste for winter recreation, both nationally and in Utah, have fueled growth in ski demand. Most of the growth in skiing in the early years was a result of increased leisure time and the taste for winter recreation encouraged by the expanding supply of ski resorts.

III.2.1.1 Utah Skiing Age Population and Resident Skier Visits

Figure 4 compares the Utah population aged 15 to 44 with resident skier visits at Utah ski resorts since 1960. The most interesting point about Figure 4 is that the decade of greatest growth in resident skier visits, the 1970s, was also the decade of the most rapid increase in Utah's skiing age population. During the 1970s, resident skier visits doubled from about 500,000 per season to about 1 million. At the same time visits doubled, the skiing age population grew more than 4 percent per year, increasing from about 450,000 to about 680,000. Another interesting feature implied by Figure 4 is that the rate of visitation between 1960 and 1980 more than tripled from about 0.5 visits per skiing age person to about 1.8 visits per skiing age, but has fallen off since 1980 to the 1.4 range recently.

Given the historical relationship between Utah's skiing age population and resident visits to Utah ski resorts, Figure 5 suggests resident visits will continue the increase of the 1990s over the 1980s into the 2000s. For the most part, projected growth rates for Utah's skiing age population remain in the 2.0 percent range during the 2000s, which contrasts with growth rates in the 1.0 percent to 1.5 percent range in the 1980s. Thus, simply because skiing age population will grow faster, resident skier visits in the 2000s should increase in contrast to the decline experienced during the 1980s.

III.2.1.2 U.S. Skiing Age Population, National Skier Visits and Destination Skier Visits in Utah

Using the logic that indicates Utah's resident skier visits should increase because of accelerating population growth, Figure 6 suggests skier visits nationally will experience little if

any growth because of decelerating growth in the U.S skiing age population. During the 1960s and 1970s when skiing experienced rapid growth nationally, the U.S. population aged 15 to 54 increased almost 2.0 percent per year from about 90 million in 1960 to about 130 million in 1980. In contrast, during the 1980s and 1990s, when skiing nationally has experienced essentially no growth, the U.S. skiing age population has been growing about 1.0 percent per year. Given this 1.0 percent population growth sustained a flat market, it is unlikely the projected population growth of 0.3 percent per year will support much growth in skiing.

Though Figure 6 suggests a flat market nationally, Figure 7 suggests Utah's appeal to destination skiers may continue to increase despite national trends. Relative to 1979, U.S. skiing age population grew more rapidly than national skier visits, but destination skier visits to Utah resorts grew three times the national population. Thus, there are dynamics particular to Utah's ski resorts, which are increasing the number of skiers they attract from the national market, even though the national market is flat. Put simply, Utah's ski resorts are winning skiing's zero sum game.

III.2.2 Utah Skier Visits and Ski Lift Capacity

As Figure 8 demonstrates, Utah skier visits and lift capacity are highly related. The industry standard measure of lift capacity is known as vertical transport feet per hour (VTF). Basically, if a lift has 1 million VTF, on average, it can transport 1,000 skiers up the mountain 1,000 vertical feet per hour. The relationship between VTF and skier visits is striking: the correlation coefficient between the two is 0.969, which indicates 96.9 percent of the variation in one of the variables is accounted for by the variation of the other variable. If forecasting VTF were not fraught with controversy, it would be an excellent predictor of skier visits. However, because forecasting VTF involves implicit decisions about land use on Utah's National Forests, GOPB did not use VTF in the skier visit forecasting equations discussed below.

III.2.3 Utah Skier Visits and Snow Conditions

Snow is obviously the most essential determinant of skiing. The role of snow is mostly as a negative influence in the sense that less than average snowfall necessarily results in less than average skier visits, but more than average snowfall does not necessarily result in more than average skier visits. The introduction of snowmaking at ski resorts, however, has changed the relationship between skiing and snowfall so that the number of skier visits is less sensitive to natural snowfall.

III.2.3.1 Historical Relationship between Visits and Snow

Figure 9 tangibly demonstrates the fact that the presence of snow allows skier visits to be determined by various socio-economic influences, but the absence of snow means skiing does not occur. GOPB looked at various indicators of snowfall in Utah before selecting the number of days Brighton reports over 40 inches of snow presented in Figure 9. Since 1960, Utah has experienced one severe drought winter, which was in the 1976-77 ski season. During that year, Utah did not experience significant snowfall until mid-January. Brighton reported just 34 days with over 40 inches of snow, which is less than one-third the 111-day average for the period from 1960 to 1996. Because of the sparse snowfall, the number of skier visits during 1977 fell to less than 800,000, or less than 50 percent of the 1.7 million visits recorded during 1976 and 1978. The effect of low snowfall in reducing skier visits is most dramatic in 1977, but, as Figure 9 indicates, low snowfall reduced skier visits in 1981, as well as a number of other years in the late 1980s and the 1990s. By way of summary, Figure 9 suggests if Brighton reports at least 50 days with over 40 inches of snow, the season will not be too bad. If Brighton reports more than 150 days with over 40 inches of snow, barring poor snowfall in other major U.S. ski markets, skier visits will follow their normal trend.

III.2.3.2 Snowmaking

Figure 10 presents historical data on snowmaking at Utah ski resorts from 1993 through 1997 in addition to the predicted rate of growth in acres of snowmaking and the resulting forecast of acres of snowmaking for 1998 through 2007. The importance of snowmaking is that it allows skiing to occur with substantially less natural snowfall than has been the case in the past. Snowmaking can therefore be expected to alter the historical relationship between natural snowfall and skier visits presented in Figure 9. Thus, in developing skier visit forecasts, GOPB used the snowmaking adjusted snowfall series presented in Figure 11. Rather than use the historical average of 111 days over 40 inches of snow at Brighton, GOPB adjusted the historical average so that it increases in proportion to the historical trend growth of snowmaking acres presented in Figure 10.

IV. Statewide Forecast of Skier Visits

The approach the Governor’s Office of Planning and Budget (GOPB) has taken to forecasting skier visits in Utah involves estimating separate equations for resident skiers and destination skiers. These equations were developed based on the history of skier visits in Utah and the determinants of skiing discussed above.

IV.1 Modeling Approach to Estimating Skier Visit Equations

GOPB has used a statistical technique known as linear regression to model how the

determinants of skier visits discussed above influence the actual number of skier visits observed during a given year. The basic idea is to estimate the parameters of a linear equation in which skier visits are the dependent, or left hand side (LHS) variable, and a selected group of the determinants discussed above are the independent, or right hand side (RHS) variables. Two separate forecasting equations are estimated, one for resident skier visits and one for destination skier visits. The parametric form of the skier visit forecasting equations is given in equation (1).

$$(1) \quad y_t = \beta_0 + \sum_{i=1}^{k} \beta_i * x_{it}$$

Typically, because the LHS dependent variable is not perfectly related to the RHS independent variables, equations like equation (1) are estimated with some error. Regression techniques seek to minimize the amount of error in the estimated equation. In equation (1), y_t is either resident or destination skier visits during year t, β_o is a constant parameter, the β_i are parameters representing the influence of the various determinants on skier visits, the x_{it} are the determinants in year t, t indexes the year, i indexes the determinants, and k is the number of determinants included in the equation. The β parameters are estimated from historical data on skier visits and the determinants. Skier visits are then forecast given the estimated parameters and forecasts of the determinants. Table 1 presents the regression results for both the resident and skier visit equations, each of which is discussed in more detail below.

IV.2 Resident Skier Visit Forecasting Equation

A number of equations were estimated before settling on the final form of the resident skier visit forecasting equation. The following determinants were included in the final form of the resident equation, presented below in equation (2).

1. The inflation adjusted average price of lift tickets at Alta and Park City, in dollars, denoted Price in equation (2).
2. The number of days Brighton reported over 40 inches of snow, denoted Snow in equation (2).
3. The Utah resident population aged 15 to 44, in thousands of people, denoted Population in equation (2).
4. Inflation adjusted per capita income in Utah, in dollars, denoted Income in equation (2).

The resident skier visit (RSV) equation is estimated as follows, where the units of RSV are thousands of resident skier visits and the units of the RHS independent variables are as discussed above.

(2) RSV = -844.229 - 32.730 * Price + 1.954 * Snow + 1.521 * Population + 0.111 * Income

Based on the results presented in equation (2) and Table 1, each dollar increase in the price variable is estimated to reduce resident skier visits by 32,730. Each day Brighton reports over 40 inches of snow is estimated to increase resident skier visits by 1,954. Every 1,000 additional Utah residents in the 15 to 44 age group is estimated to increase resident skier visits by 1,521. Each dollar increase in real per capita personal income in Utah is estimated to increase resident skier visits by 111, or, equivalently, a $1,000 increase in income increases visits by 111,000.

As presented in Table 1, all of the dependent variables, but income in the resident skier visit forecasting equation, are estimated to have a highly significant effect on resident skier visits. Income is estimated to be significant at the 0.041 level, which is acceptable, but indicates that relative to ticket price, snow, and population, income is not that influential. The equation was estimated using the ordinary least squares (OLS) technique since the errors computed with this technique appear to satisfy the independent identically distributed (IID) requirement. When the OLS errors do not satisfy the IID requirement, other techniques must be used to obtain minimum variance unbiased estimates of the equation's parameters.

The various statistics for the resident skier visit equation in Table 1 can be used to gauge the equation's accuracy. The standard error of the regression indicates that in a typical year, the equation will error in its estimate of resident skier visits by 80,320, which is about 6 percent of the 1.2 million visits recorded in the 1995-96 ski season. The untransformed adjusted R-square of 0.950 indicates the variation in the RHS independent variables accounts for 95.0 percent of the variation in resident skier visits. The untransformed Durbin Watson of 1.579 indicates the regression errors might be serially correlated, which would violate the IID requirement. However, other tests not presented in Table 1 indicate the serial correlation coefficient, Rho, is not significantly different from 0. Thus, OLS appears to generate the best possible parameter estimates for the resident skier visit forecasting equation.

IV.3 Destination Skier Visit Forecasting Equation

As with the resident skier equation, a number of equations were estimated before settling on the final form of the destination skier visit forecasting equation. Unlike the resident equation, however, it was not possible develop a forecasting equation for destination skiers in which the general determinants of skiing discussed above could be related to skier visits. The initial approach with the destination equation was similar to the resident equation in that visits were related to skiing determinants such as ticket price, snow, population, and income, but a satisfactory equation containing these variables could not be estimated.

Basically, the easily quantifiable determinants of national skier visits indicate there will be little if any growth in the national market. The main reason the outlook for the national market could improve is a change in recreation tastes that caused people to ski more in the future than they do now. Barring this type of change, the national market will be essentially flat over the next decade, so the number of destination skiers a resort attracts will not be influenced by national trends. Indeed, the current dynamic in the ski market involves people traveling away from their homes for an extended period to ski at a destination resort rather than ski a local area not catering to destination skiers. This dynamic is especially pronounced in the mid-West where a number of resorts with marginal ski terrain are closing as their clientele forsake the limited local skiing in favor of the mountain West. So the growth of the destination ski market in the West results more from winning a zero sum game than from an increasing number of skiers.

Initially, a destination skier visit forecast equation was estimated with the RHS price and snow variables discussed above, the U.S. population aged 15 to 54, and the growth rate of inflation adjusted gross domestic product (GDP). In the equation, neither the GDP growth rate or ticket price was significant. Since GDP growth was less significant, it was dropped and the equation was re-estimated. In this second round equation, price was still not significant. A third round equation was estimated with just snow and population. Although both these variables were highly significant, since the U.S. skiing age population is expected to grow very slowly over the next decade, this equation resulted in destination skier visit forecasts GOPB felt were too low.

The final form of the destination skier visit forecasting equation involved the following RHS variables, presented below in equation (3).

1. A time variable, measured as the year in which the visits occurred, denoted Time in equation (3).
2. The number of days Brighton reported over 40 inches of snow, denoted Snow in equation (3).

The destination skier visit (DSV) equation is estimated as follows, where the units of DSV are thousands of destination skier visits and the units of the RHS independent variables are as discussed above.

(3) $DSV = -104{,}195.000 + 52.981 * Time + 1.716 * Snow$

The intuition behind forecasting destination skier visits based on time and snow conditions is that Utah's role as a destination ski center will continue to grow even though skiing nationally will not grow. In other words, Utah's share of the national market is expected to

increase. Given the expectation destination skier visits in Utah will continue to grow but the skiing age population nationally will not increase much, the best predictor will be history and time. Thus, the best destination skier forecasting equation will relate visits to time, but account for the effects of snow, which is the idea captured in equation (3).

Based on the results presented in Table 1 and equation (3), destination skier visits are predicted to increase 52,981 per year, when considering just time. Each day Brighton reports over 40 inches of snow is estimated to increase destination skier visits 1,716. Both time and snow are highly significant in the forecasting equation.

The equation appears to capture the dynamics governing Utah's destination ski market reasonably well. The standard error of the regression indicates the equation errors in its prediction by 90,073 on average, which is about 5 percent of destination visits during the 1995-96 ski season. The untransformed adjusted R-square of 0.978 indicates the variation in the RHS independent variables accounts for 97.8 percent of the variation in destination skier visits. The untransformed Durbin Watson of 0.787 indicates the OLS errors are serially correlated, so that OLS is not a good technique to estimate the equation. Thus a maximum likelihood (ML) technique which involves transforming the data to account for serial correlation was used to estimate the equation. Using this technique, the serial correlation coefficient, Rho, was estimated to be 0.718. The transformed adjusted R-square of 0.821 indicates the variation in the transformed RHS independent variables accounts for 82.1 percent of the variation in transformed destination skier visits. The transformed Durbin Watson of 1.890 indicates the ML errors are not serially correlated, so the ML technique used to estimate equation (3) appears to generate the best possible parameter estimates.

IV.4 Olympics Effect in Destination Skier Visit Equation

In June 1989, the United States Olympic Committee selected Salt Lake City as "America's Choice" to bid for the 1998 Olympic Winter Games, and, if the 1998 bid failed, the 2002 Games. In June 1995, Salt Lake City was selected by the International Olympic Committee to host the 2002 Games. Because of the notoriety Utah will receive from hosting the 2002 Olympic Winter Games, it seems likely destination skier visits to Utah will increase in the period after the Games above what would have been the case if the Games were held elsewhere.

GOPB used a variety of statistical techniques to identify an Olympics effect in the historical data on destination skier visits, but no such effect is evident in the data. The basic approach was to select a year in which the effect was thought to have begun and examine whether the statistical properties of the destination skier visit data series after that year are different from before the year. Given the history of Salt Lake City's bid, 1989 and 1995 are the

two obvious years. Unfortunately, the data series after these years is too short to allow precise statistical inference concerning an Olympics effect. There is just one observation after 1995 and only seven after 1989. Consequently, GOPB chose not to utilize statistical techniques to isolate an Olympic effect in the destination skier visit projections.

This does not mean that there is no Olympic effect. Rather, the time frame is simply too short to statistically isolate what portion of current and future increases in skier visits are attributable to Utah's provision of the Olympic Winter Games. Instead, an Olympic effect is embedded in the skier visit projections via the time variable. To the extent that the selection of Salt Lake City as America's choice and the world's choice to host the Games has impacted skier visits, this impact is captured by the time variable.

GOPB has also examined skier visits to major Alberta resorts prior to and after the 1988 Calgary Olympic Winter Games. Skier visits in Alberta followed an upward growth path in the three years prior to and after the Games. Skier visits at major Alberta resorts increased by an average annual rate of change of 5.0 percent from 1985 to 1991. GOPB's projections follow a similar growth path as those experienced in Alberta, albeit at a lower growth rate. A lower rate is appropriate in Utah given the historical growth in skier visits and the larger size of the ski industry. Utah's ski industry is three times larger than that of Alberta's.

The Alberta data also show a very clear, distinct displacement effect in the year of the Games. Skier visits at major Alberta resorts declined by 18 percent in the year of the Games and rebounded by 24 percent in the year following the Games. This displacement occurs as visitors chose to attend Olympic events instead of ski or simply not come to Alberta in the year of the Games. A displacement effect will also occur in Utah in 2002 although the magnitude is not known. Because of this uncertainty, GOPB has not adjusted the skier visit projections in 2002, but recognizes the likelihood of a year break in the projected increases.

V. Procedure to Allocate Statewide Skier Visits to the 14 Resorts

GOPB used a transportation planning technique known as the gravity model, which will be described in more detail below, to allocate skier visits among the 14 ski resorts. Separate gravity models were built for resident skier visits and destination skier visits. Gravity models estimate the number of trips from where people stay to where they want to go. In the case of resident skiers, the population in a given area is used as the base from where resident trips to the various ski resorts begin. Survey data is used to estimate where destination skiers stay when they begin their trips to the resorts.

V.1 Theoretical Structure of Gravity Models

Gravity models have been used in transportation planning for several decades. The concept of gravity is connected with these models because they are an adaptation of Newton's law of gravity: the attraction between two objects is directly related to their respective masses and inversely related to the distance between them. A matrix of origins and destinations is the main analytical construct of gravity models. With origins as the rows of the matrix and destinations as the columns, each cell represents an origin-destination (OD) pair. Gravity models estimate the number of trips from origin i to destination j, $T_{ij,}$ where i indexes origins and j indexes destinations. Equation 4 contains the basic form of the gravity model, where k is a constant of proportionality defined in equation 5 below, O_i is a surrogate measure of the number of trips beginning in origin i, T_i, A_j is a measure of the attractiveness of destination j, e is the exponential function, α is the rate of decay in the attractiveness of destination j, d_{ij} is the minutes of travel time between origin i and destination j, and L is the number of destinations. The term $e^{-\alpha * d_{ij}}$ in equation (4) is often called a friction factor because it acts to impede the number of trips between origin i and destination j, and α is the coefficient of friction.

$$(4) \quad T_{ij} = \frac{k * O_i * A_j * e^{-\alpha * d_{ij}}}{\sum_{j=1}^{L} A_j * e^{-\alpha * d_{ij}}}$$

$$(5) \quad k = \frac{\sum_{j=1}^{M} T_j}{\sum_{i=1}^{L} O_i}$$

The constant of proportionality, k, as defined in equation (5), is used to normalize the surrogate measure of the number of trips originating so that the total of this measure is the same magnitude and has the same units as the total of the number of trips arriving at the M destinations. Equation (6) contains an important relationship of gravity models: the total of all the trips between the various OD pairs is identically equal to the total of all the trips beginning from the various origins which is identically equal to the total of all the trips arriving at the various destinations. It can be the case, as with the destination skier gravity model described below, that the surrogate measure of the number of trips originating is the same as the number of trips. When this is the case, $O_i = T_i$, so, by equation (5), k is equal to 1. As described below, the surrogate measure of trips originating in the resident skier gravity model is the resident

population in each origin area, which implies k will be less than 1, since the number of resident skier visits is less than Utah's population.

$$(6) \quad \sum_{ij} T_{ij} \equiv \sum_{i} T_{i} \equiv \sum_{j} T_{j}$$

$$(7) \quad A_j = \beta_{0j} * \dot{VTF}_j^{\beta_1} * \dot{SNOW}_j^{\beta_2} * \dot{PRICE}_j^{\beta_3}$$

$$(8) \quad \dot{VTF}_j = \frac{VTF_j}{\frac{\sum_{j=1}^{14} VTF_j}{14}}$$

$$(9) \quad A_j = \beta_{0j} * \dot{VTF}_j^{\beta_1} * \dot{SNOW}_j^{\beta_2} * \dot{PRICE}_j^{\beta_3} * \dot{ROOMS}_j^{\beta_4}$$

The attractiveness measure defined in equation (4), A_j, captures the influence a particular resort's features have on the number of visits to the resort. GOPB developed different attractiveness measures for resident and destination skiers. The resident skier attractiveness measure includes a resort specific effect, VTF, snow and lift ticket price, as presented in equation (7). The variables in equation (7) are measured as relative deviations from the mean value for the 14 ski resorts. The term $\dot{VTF}_j$ in equation (7), for example, is resort j's VTF relative to the average VTF at all 14 resorts, as presented in equation (8). The other variables in equations (7) and (9) are defined in similar fashion to $\dot{VTF}_j$ in equation (8). The parameter β_{oj} in equation (7) represents the resort specific effect, β_1 is the elasticity of attractiveness with respect to VTF relative to mean, β_2 is the elasticity of attractiveness with respect to snowfall relative to mean, and β_3 is the elasticity with respect to lift ticket price relative to mean. The destination skier attractiveness measure, presented in equation (9), is essentially the same as the resident measure, except that the number of rooms at the resort available to be rented to destination skiers is included in addition to the other variables. The β parameters in equation (9) have the same definition (though not the same numerical value), as in equation (7), and β_4 is the elasticity of attractiveness with respect to rooms relative to mean.

V.2 Results of Gravity Model Calibration

Table 2 presents the results of the gravity model calibration. Both models calibrated perfectly in that the number of visits to each resort predicted by the model in the 1995-96 ski season equaled the number recorded. The results for the resident skier gravity model presented in Table 2 can be summarized as follows.

1. A 10 percent increase in VTF relative to average results in a 2.6 percent increase in attractiveness.
2. A 10 percent increase in price relative to average results in a 5.9 percent decrease in attractiveness.
3. A 10 percent increase in snow relative to average results in a 4.8 percent increase in attractiveness.
4. Attractiveness decreases 50 percent for each 22 minutes of travel time.

The results for the destination skier gravity model presented in Table 2 can be summarized as follows.

1. A 10 percent increase in VTF relative to average results in a 10.3 percent increase in attractiveness.
2. A 10 percent increase in price relative to average results in a 29.9 percent decrease in attractiveness.
3. A 10 percent increase in snow relative to average results in an 11.0 percent increase in attractiveness.
4. Attractiveness decreases 50 percent for each 19 minutes of travel time.

V.3 Allocation of Skier Visits during 1995-96 Season with Gravity Model

As mentioned above, both the resident and destination skier visit gravity models calibrated perfectly in that the visits to each resort for the 1995-96 season predicted by the models equaled the actual number of visits recorded. Although the gravity model was implemented in full detail, the visit allocation to destinations has been summarized from 14 individual resorts to eight resort groups. The visits originating by origin are presented in full detail.

V.3.1 Resident Skier Visit Allocation

Table 3 presents the allocation of 1996 resident skier visits to the resort groups, termed destinations, from where the skiers live, termed origins. Resident skiers are assumed to be

uniformly distributed throughout the population so the visits originating from a particular part of the state are directly proportional to population. The intuitive appeal of the gravity model logic is reflected in the results for Snow Basin and the Summit County Resorts. Snow Basin is a good example of the role of distance while the Summit County Resorts are a good example of the role of size.

Snow Basin had 42,800 resident skier visits in 1996, which is the predicted number from the gravity model. Without considering population size in a given area, the number of visits diminishes with the distance from the resort. 19,100 of the visits are estimated to have come from Weber and Morgan Counties, 7,100 from North Davis County, 2,400 from South Davis County, and (after totaling the six sub-county areas) 5,700 from Salt Lake and Tooele Counties. So even though South Davis County is closer to Snow Basin, and even though relative to resorts located nearer Salt Lake County, few people in Salt Lake County ski at Snow Basin, because many more people live in Salt Lake than South Davis, more people from Salt Lake ski at Snow Basin than from South Davis.

The Summit County Resorts had 350,600 resident skier visits, as predicted by the gravity model. In many cases, the Summit County Resorts attracted more visits from a particular origin than nearby resorts. While most visits came from Salt Lake County, substantial numbers came from all over the state, which reflects the role of size in attracting visits. For example, the Summit County Resorts attracted 9,200 skier visits from residents in Washington, Kane and Garfield Counties, which was 70 percent of the 13,100 visits from these counties to Brian Head, which is much closer. Further, of the 113,400 skier visits made by Weber and Morgan County residents, 27,300 were made to Summit County Resorts, which was more than any other resort, including Snow Basin, which is estimated to have received 19,100 visits from Weber and Morgan County residents. So even though Snow Basin is much closer, Weber and Morgan County residents are estimated to make more ski visits to the Summit County Resorts because these resorts have more facilities.

V.3.2 Destination Skier Visit Allocation

Table 4 presents the allocation of 1996 destination skier visits to the resort groups from where the skiers are staying. Estimates of where destination skiers stay were developed by GOPB based on the number of rooms at the resorts and the skier surveys sponsored by Ski Utah in cooperation with the Utah Travel Council and the Park City Chamber of Commerce. As in the resident model, size and distance are evident in the destination allocation. Most of the skiers at the Summit County Resorts, for example, stay in Summit County, but a fair number come from Salt Lake County as well as a few from the Cottonwood Canyons.

VI. Results of the Allocation Procedure under Two Alternatives

After calibrating the gravity model parameters, the models were used to allocate the statewide skier visit forecasts under two alternative scenarios concerning ski lift development at three Cottonwood Canyons Resorts: Brighton, Snowbird and Solitude. These alternatives are termed proposed action and no action in the environmental analysis being conducted by the U.S. Forest Service. Although it is conceivable total skier visits statewide could differ under the two alternatives, the proposed action is sufficiently similar to existing conditions at the resorts that it appears unlikely to significantly impact visitation. The proposed action involves the addition of ski lifts with 4.8 million VTF, 2.3 million VTF at Snowbird and 2.5 million VTF at Solitude. Under the no action scenario, VTF statewide is forecast to be almost 220 million in 2007. Thus, relative to the no action scenario, the proposed action is anticipated to increase lift capacity statewide about 2 percent, which is unlikely to be significant enough to impact visitation.

VI.1 Statewide Skier Visits

Table 5 presents historic and forecast resident and destination skier visits. From 1990 to 1996, total skier visits grew 7.8 percent per year, resident visits grew 5.6 percent per year, and destination visits grew 12.0 percent per year. Average growth since 1960 captures the phenomenal increase in skiing's popularity during the early days and masks the industry slowdown that occurred after 1980. From 1980 to 1986, total skier visits grew 2.2 percent per year, less than one-third the rate from the period including skiing's early days. Resident visits grew just 0.7 percent per year during this period, though destination visits grew 3.5 percent per year. For the period from 1985 to 1996, which matches the length of the forecast period, the growth in total skier visits shrunk to just 1.8 percent per year. Resident skier visits grew 0.7 percent per year and destination visits grew 2.6 percent per year.

Given that destination visits have grown more rapidly than resident visits during each of the historic periods analyzed above, it is somewhat surprising that resident visits are forecast to grow faster than destination visits. The explanation, as discussed at length above, is that the national market is expected to have little growth during the forecast period while Utah's skiing age population is expected to grow more rapidly than during the 1980s and 1990s. The forecast growth rate for total skier visits, 3.4 percent, is higher than during the 1980s, almost twice the 1.8 percent observed from 1985 to 1996. Resident skier visits are forecast to grow at 3.9 percent, as compared to 0.7 percent in the most recent historic period, while destination visits grow at 3.1 percent, as compared to 2.6 percent recently, and 3.5 percent since 1980.

VI.2 Skier Visit Allocation under the Proposed Action Alternative

Table 6 and Figure 12 present the results of the skier visit allocation under the proposed action. Skier visits at all the resort groups increase between 1996 and 2007. The largest increase, 698,700 visits, occurs at the Summit County Resorts, which, in addition to maintaining the largest market share, also increase their share from about 36 percent to about 42 percent. While the Summit County Resorts maintain first position, Snowbasin is forecast to have the fastest growth, 237.9 percent. Because of Snowbasin's expansion plans, its visits are forecast to more than triple, from 64,000 in 1996 to 216,200 in 2007, while its market share increases from about 2 percent to just over 5 percent. Solitude and Snowbird are both forecast to benefit from expansion, with large growth in absolute and percentage terms, and with modest increases in market share. In contrast, because they have no expansion plans, visits at Alta and Brighton increase only slightly. Moreover, market share at Alta falls from about 16 percent to about 12 percent, while Brighton's falls from about 13 percent to about 9 percent.

VI.3 Skier Visit Allocation under the No Action Alternative

Table 7 and Figure 13 present the results of the skier visit allocation under no action. As with the proposed action, skier visits at all the resort groups increase between 1996 and 2007. The character of the results at each of the resort groups is similar to the proposed action, but the six resort groups whose facilities are not effected by the proposed action gain at the expense of Solitude and Snowbird. Snowbird actually loses market share with no action, while Solitude's gain in market share is dampened. Alta and Brighton still lose market share, though not as much as under the proposed action.

VII. Conclusion

The Forest Service contracted with GOPB to conduct this study so the environmental analysis of the three Cottonwood Canyons resorts would integrate with the dynamics governing the overall Utah ski market. Because skier visit forecasts for each of the resorts are made as part of a process which forecasts skier visits statewide, the forecasts are consistent with each other. In other words, GOPB's technique assures skier visit forecasts at each of the Cottonwood Canyons resorts used in the respective EISs are consistent with each other and that these forecasts are consistent with expectations for the Utah ski market as a whole.

GOPB forecasts total skier visits in Utah to grow from around 3 million currently, to over 4 million by 2007. The forecast annual rate of growth, 3.4 percent, is lower than the long-term rate of 7.8 percent since 1960, but almost twice the recent rate of 1.8 percent since 1985. The major reason skier visit growth to 2007 is expected to grow more rapidly than since 1985 is that Utah's skiing age population will grow much more rapidly to 2007 than it has since 1985. Destination skier visits are expected to grow a bit more rapidly to 2007, 3.1 percent per year,

than they have recently, 2.6 percent since 1985, but more slowly than the 3.5 percent observed since 1980. Since resident skier visits are forecast to grow only slightly more rapidly than destination visits, the destination share of the market is expected to barely decline, from 56.8 percent to 56.3 percent. In sum, Utah's ski market is expected to grow a bit more rapidly in the next decade than it has in the last, but nowhere near as rapidly as it did in the 1970s, when skier visits doubled. Utah's emergence as a destination ski center will be sustained, but the destination share of the market is expected to remain essentially constant.

Table 1
Regression Results for Skier Visit Equations

Resident Skier Visits

	Parameters			
Variable	Estimate	Standard Error	P-Value	Statistics
Constant	-844.229	249.478	0.002	Standard error of regression 80.320
Price	-32.730	5.651	0.000	Untransformed adjusted R-square 0.950
Snow	1.954	0.365	0.000	Untransformed Durbin Watson 1.579
Population	1.521	0.469	0.003	
Income	0.111	0.052	0.041	

Destination Skier Visits

	Parameters			
Variable	Estimate	Standard Error	P-Value	Statistics
Constant	-104,195.000	8,030.560	0.000	Standard error of regression 90.073
Time	52.981	4.060	0.000	Untransfromed adjusted R-square 0.978
Snow	1.716	0.332	0.000	Transformed adjusted R-square 0.821
				Untransformed Durbin Watson 0.787
				Transformed Durbin Watson 1.890
				Rho 0.718

Notes

1. Price is the inflation adjusted average of ticket prices at Alta and Park City.
2. Snow is the number of days Brighton reports over 40 inches of snow.
3. Population is Utah resident population aged 15 to 44.
4. Income is inflation adjusted per capita personal income in Utah.

Table 2
Results of Gravity Model Calibration

	Resident	Destination
Constant of Proportionality	0.614	1.000
Travel Parameters		
Rate of Decay	0.032	0.037
Half Life (in minutes)	21.643	18.560
Elasticities		
VTF	0.264	1.027
Price	-0.585	-2.988
Snow	0.480	1.095
Room	-	0.520
Resort Specific Effects		
Alta	1.301	0.426
Beaver Mountain	2.658	0.417
Brian Head	0.006	0.503
Brighton	2.168	2.495
Deer Valley	1.525	0.756
Elk Meadows	0.023	1.507
Nordic Valley	0.133	0.117
Park City	1.725	0.461
Powder Mountain	0.298	0.436
Snowbasin	0.518	0.736
Snowbird	1.267	1.018
Solitude	1.238	1.599
Sundance	1.600	1.939
The Canyons	1.763	0.289

Table 3
Gravity Model Allocation of Resident Skier Visits during 1995-96 Ski Season
(In Thousands)

	Destinations									
Origins	Alta	Brian Head	Brighton	Snow Basin	Snowbird	Solitude	Summit County Resorts	Other Resorts	Total Visits Orginating	1996 Population (Thousands)
American Fork Area	7.4	0.0	7.8	0.4	5.5	4.5	10.4	7.4	43.3	70.6
Bear River MCD	2.2	0.0	2.5	5.6	1.6	1.4	7.2	55.2	75.7	123.4
Central East Salt Lake County	17.7	0.0	20.6	0.9	13.1	11.8	25.5	4.0	93.5	152.4
Central MCD	7.1	0.0	7.7	0.4	5.4	4.4	8.4	4.1	37.4	61.0
Central West Salt Lake County	25.1	0.0	29.2	1.7	18.6	16.8	38.5	6.5	136.3	222.2
Iron and Beaver Counties	1.8	8.9	2.0	0.1	1.4	1.1	2.7	2.6	20.6	33.6
Kamas and Coalville	0.3	0.0	0.3	0.1	0.2	0.2	1.8	0.3	3.2	5.2
North Davis County	11.7	0.0	13.6	7.1	8.7	7.6	22.2	12.5	83.4	135.9
Northeast Salt Lake County	10.0	0.0	12.1	0.8	7.4	6.9	20.5	3.4	61.2	99.7
Northwest Salt Lake and Tooele	9.4	0.0	10.9	0.8	6.9	6.1	17.4	3.0	54.5	88.7
Park City	0.6	0.0	0.8	0.1	0.5	0.4	8.0	0.8	11.3	18.4
Provo Area	12.0	0.0	13.1	0.6	8.9	7.3	43.4	29.2	114.4	186.4
South Davis County	8.0	0.0	9.3	2.4	6.1	5.3	15.3	5.0	51.4	83.8
Southeast MCD	2.1	0.0	2.6	0.3	1.6	1.5	20.0	5.2	33.3	54.2
Southeast Salt Lake County	23.2	0.0	23.7	0.8	17.1	13.2	21.7	4.7	104.3	170.0
Southwest Salt Lake County	14.0	0.0	15.8	0.7	10.4	9.1	17.2	4.2	71.4	116.3
Spanish Fork Area	4.1	0.0	4.4	0.2	3.1	2.5	14.8	8.3	37.4	60.9
Uintah Basin MCD	1.5	0.0	1.9	0.2	1.2	1.1	14.5	3.6	24.0	39.1
Wasatch County	0.5	0.0	0.6	0.1	0.4	0.3	4.7	1.2	7.7	12.6
Washington, Kane and Garfield Counties	6.2	13.1	6.5	0.4	4.6	3.7	9.2	7.4	51.1	83.2
Weber and Morgan Counties	11.4	0.0	13.2	19.1	8.4	7.3	27.3	26.7	113.4	184.8
Predicted Visits	176.3	22.0	198.8	42.8	130.8	112.4	350.6	195.2	1,228.9	2,002.4
Actual Visits	176.3	22.0	198.8	42.8	130.8	112.4	350.6	195.2	1,228.9	
Error	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Percent Error	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	

Notes

1. Summit County Resorts include Deer Valley, Park City and The Canyons
2. Other Resorts include Beaver Mountain, Elk Meadows, Nordic Valley, Powder Mountain and Sundance.
3. Population was used as the surrogate measure of trips originating, so the constant of proportionality is the ratio of total resident skier visits, 1,228,900, to total population, 2,002,400, or 0.614.

Table 4
Gravity Model Allocation of Destination Skier Visits during 1995-96 Ski Season
(In Thousands)

	Destinations								
Origins	Alta	Brian Head	Brighton	Snow Basin	Snowbird	Solitude	Summit County Resorts	Other Resorts	Total Visits Orginating
Alta	31.6	0.0	8.7	0.1	21.7	5.0	7.2	0.8	75.1
Beaver Mountain	0.1	0.0	0.0	0.1	0.1	0.0	0.2	0.9	1.4
Brian Head	0.0	90.4	0.0	0.0	0.0	0.0	0.0	0.6	91.0
Brighton	1.1	0.0	2.8	0.0	0.8	1.3	0.7	0.1	6.7
Cedar City	0.0	25.1	0.0	0.0	0.0	0.0	0.0	0.9	26.1
Deer Valley	13.7	0.0	9.2	0.9	10.1	5.1	143.4	7.1	189.5
Downtown Salt Lake	89.7	0.0	56.3	3.4	68.8	32.3	105.0	7.8	363.3
Elk Meadows	0.0	0.1	0.0	0.0	0.0	0.0	0.0	26.8	26.9
South Salt Lake County	71.8	0.0	45.1	1.2	53.0	24.9	49.8	4.8	250.7
The Canyons	3.0	0.0	2.0	0.2	2.3	1.2	19.5	1.1	29.3
Ogden Area	5.6	0.0	3.5	5.7	4.1	1.9	8.5	4.3	33.7
Park City	28.0	0.0	18.2	1.8	20.7	10.4	323.9	14.6	417.5
Provo Area	4.0	0.0	2.3	0.1	3.0	1.3	8.1	3.6	22.3
Snow Basin	1.8	0.0	1.5	7.4	1.3	0.9	5.7	2.7	21.2
Snowbird	45.1	0.0	13.4	0.2	33.3	7.7	11.0	1.3	112.0
Solitude	1.3	0.0	2.8	0.0	1.0	1.6	0.9	0.1	7.7
Sundance	4.9	0.0	4.2	0.1	3.6	2.5	21.6	13.9	50.8
Predicted Visits	301.5	115.6	170.0	21.2	223.7	96.2	705.3	91.6	1,725.1
Actual Visits	301.5	115.6	170.0	21.2	223.7	96.2	705.3	91.6	1,725.1
Error	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent Error	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Notes

1. Summit County Resorts include Deer Valley, Park City and The Canyons
2. Other Resorts include Beaver Mountain, Elk Meadows, Nordic Valley, Powder Mountain and Sundance.

Table 5
Historical and Forecast Resident and Destination Skier Visits

	Skier Visits			Growth Rate in Skier Visits			Shares	
	Total	Resident	Destination	Total	Resident	Destination	Resident	Destination
1960	199.8	170.6	29.2				85.4%	14.6%
1961	269.5	230.1	39.4	34.9%	34.9%	34.9%	85.4%	14.6%
1962	271.7	231.9	39.8	0.8%	0.8%	1.0%	85.4%	14.6%
1963	210.0	183.8	26.3	-22.7%	-20.8%	-34.0%	87.5%	12.5%
1964	340.0	306.0	34.0	61.9%	66.5%	29.5%	90.0%	10.0%
1965	388.0	340.8	47.2	14.1%	11.4%	38.8%	87.8%	12.2%
1966	442.0	377.0	65.0	13.9%	10.6%	37.8%	85.3%	14.7%
1967	504.0	414.8	89.2	14.0%	10.0%	37.1%	82.3%	17.7%
1968	540.0	425.9	114.1	7.1%	2.7%	27.9%	78.9%	21.1%
1969	555.0	416.1	138.9	2.8%	-2.3%	21.7%	75.0%	25.0%
1970	649.0	458.3	190.7	16.9%	10.2%	37.3%	70.6%	29.4%
1971	862.0	567.7	294.3	32.8%	23.9%	54.3%	65.9%	34.1%
1972	1,088.0	661.0	427.0	26.2%	16.4%	45.1%	60.8%	39.2%
1973	1,370.0	759.0	611.0	25.9%	14.8%	43.1%	55.4%	44.6%
1974	1,301.0	743.5	557.5	-5.0%	-2.0%	-8.8%	57.1%	42.9%
1975	1,411.0	831.0	580.0	8.5%	11.8%	4.0%	58.9%	41.1%
1976	1,674.0	961.9	712.1	18.6%	15.8%	22.8%	57.5%	42.5%
1977	789.0	442.0	347.0	-52.9%	-54.1%	-51.3%	56.0%	44.0%
1978	1,672.0	912.3	759.7	111.9%	106.4%	118.9%	54.6%	45.4%
1979	2,223.0	1,180.4	1,042.6	33.0%	29.4%	37.2%	53.1%	46.9%
1980	2,093.0	1,093.1	999.9	-5.8%	-7.4%	-4.1%	52.2%	47.8%
1981	1,740.0	893.5	846.5	-16.9%	-18.3%	-15.3%	51.4%	48.6%
1982	2,038.5	1,029.0	1,009.5	17.2%	15.2%	19.3%	50.5%	49.5%
1983	2,317.3	1,149.4	1,167.8	13.7%	11.7%	15.7%	49.6%	50.4%
1984	2,369.9	1,140.4	1,229.5	2.3%	-0.8%	5.3%	48.1%	51.9%
1985	2,436.5	1,137.3	1,299.2	2.8%	-0.3%	5.7%	46.7%	53.3%
1986	2,491.2	1,128.1	1,363.1	2.2%	-0.8%	4.9%	45.3%	54.7%
1987	2,440.7	1,072.1	1,368.6	-2.0%	-5.0%	0.4%	43.9%	56.1%
1988	2,369.0	1,009.5	1,359.5	-2.9%	-5.8%	-0.7%	42.6%	57.4%
1989	2,572.2	1,063.3	1,508.9	8.6%	5.3%	11.0%	41.3%	58.7%
1990	2,491.0	999.0	1,492.0	-3.2%	-6.0%	-1.1%	40.1%	59.9%
1991	2,751.6	1,100.6	1,650.9	10.5%	10.2%	10.7%	40.0%	60.0%
1992	2,560.8	1,024.3	1,536.5	-6.9%	-6.9%	-6.9%	40.0%	60.0%
1993	2,850.0	1,140.0	1,710.0	11.3%	11.3%	11.3%	40.0%	60.0%
1994	2,808.0	1,156.0	1,652.0	-1.5%	1.4%	-3.4%	41.2%	58.8%
1995	3,113.0	1,295.0	1,818.0	10.9%	12.0%	10.0%	41.6%	58.4%
1996	2,954.0	1,228.9	1,725.1	-5.1%	-5.1%	-5.1%	41.6%	58.4%
				Forcast begins				
1997	3,217.6	1,390.4	1,827.2	8.9%	13.1%	5.9%	43.2%	56.8%
1998	3,346.0	1,452.8	1,893.2	4.0%	4.5%	3.6%	43.4%	56.6%
1999	3,450.1	1,493.7	1,956.4	3.1%	2.8%	3.3%	43.3%	56.7%
2000	3,554.1	1,536.7	2,017.3	3.0%	2.9%	3.1%	43.2%	56.8%
2001	3,659.6	1,583.1	2,076.5	3.0%	3.0%	2.9%	43.3%	56.7%
2002	3,777.7	1,643.6	2,134.1	3.2%	3.8%	2.8%	43.5%	56.5%
2003	3,856.2	1,665.5	2,190.7	2.1%	1.3%	2.6%	43.2%	56.8%
2004	3,963.2	1,716.9	2,246.3	2.8%	3.1%	2.5%	43.3%	56.7%
2005	4,071.8	1,770.5	2,301.3	2.7%	3.1%	2.4%	43.5%	56.5%
2006	4,174.3	1,818.4	2,355.9	2.5%	2.7%	2.4%	43.6%	56.4%
2007	4,279.5	1,869.6	2,410.0	2.5%	2.8%	2.3%	43.7%	56.3%
	Average Annual Growth Rates							
1960 to 1996	7.8%	5.6%	12.0%					
1980 to 1996	2.2%	0.7%	3.5%					
1985 to 1996	1.8%	0.7%	2.6%					
1996 to 2007	3.4%	3.9%	3.1%					

Table 6
Proposed Action
Allocation of Statewide Skier Visit Forecasts to Resort Groups
(In Thousands, Selected Years)

	Annual Visits								Growth from 1996 to 2007	
Resort Group	1996	1998	2000	2002	2004	2005	2006	2007	Amount	Rate
Alta	477.8	492.3	455.2	463.2	474.7	484.7	496.9	509.9	32.1	6.7%
Brian Head	137.6	147.7	135.8	134.8	137.8	140.3	142.6	145.0	7.4	5.4%
Brighton	368.8	430.1	389.8	366.7	366.5	369.6	373.4	377.4	8.6	2.3%
Snowbasin	64.0	57.9	128.2	200.9	203.6	206.8	211.4	216.2	152.2	237.9%
Snowbird	354.5	395.1	459.7	467.9	484.5	497.0	512.7	529.3	174.8	49.3%
Solitude	208.6	297.2	298.3	335.8	351.4	360.2	370.0	379.4	170.8	81.9%
Summit County	1,055.9	1,212.5	1,367.7	1,483.2	1,605.7	1,665.0	1,709.7	1,754.6	698.7	66.2%
Others	286.8	313.2	319.4	325.2	339.0	348.2	357.6	367.8	81.0	28.2%
Total	2,954.0	3,346.0	3,554.1	3,777.7	3,963.2	4,071.8	4,174.3	4,279.5	1,325.5	44.9%

Notes

1. Summit County Resorts include Deer Valley, Park City and The Canyons.
2. Other Resorts include Beaver Mountain, Elk Meadows, Nordic Valley, Powder

Table 7
No Action
Allocation of Statewide Skier Visit Forecasts to Resort Groups
(In Thousands, Selected Years)

	Annual Visits								Growth from 1996 to 2007	
Resort Group	1996	1998	2000	2002	2004	2005	2006	2007	Amount	Rate
Alta	477.8	491.9	453.8	475.4	487.2	497.4	510.0	523.3	45.5	9.5%
Brian Head	137.6	147.7	135.8	135.0	138.1	140.5	142.8	145.3	7.7	5.6%
Brighton	368.8	429.8	388.6	374.1	374.0	377.2	381.1	385.1	16.3	4.4%
Snowbasin	64.0	60.2	141.3	224.6	227.5	231.0	236.0	241.3	177.3	277.0%
Snowbird	354.5	394.8	458.0	442.5	458.4	470.5	485.4	501.2	146.7	41.4%
Solitude	208.6	297.0	297.0	299.0	312.9	320.9	329.7	338.1	129.5	62.1%
Summit County	1,055.9	1,211.5	1,361.7	1,501.7	1,625.9	1,686.1	1,731.7	1,777.4	721.5	68.3%
Others	286.8	312.9	317.8	325.4	339.2	348.3	357.6	367.8	81.0	28.2%
Total	2,954.0	3,346.0	3,554.1	3,777.7	3,963.2	4,071.8	4,174.3	4,279.5	1,325.5	44.9%

Notes

1. Summit County Resorts include Deer Valley, Park City and The Canyons.
2. Other Resorts include Beaver Mountain, Elk Meadows, Nordic Valley, Powder Mountain and Sundance.

Figure 1

US Skier Visits and Utah's Share of the National Ski Market

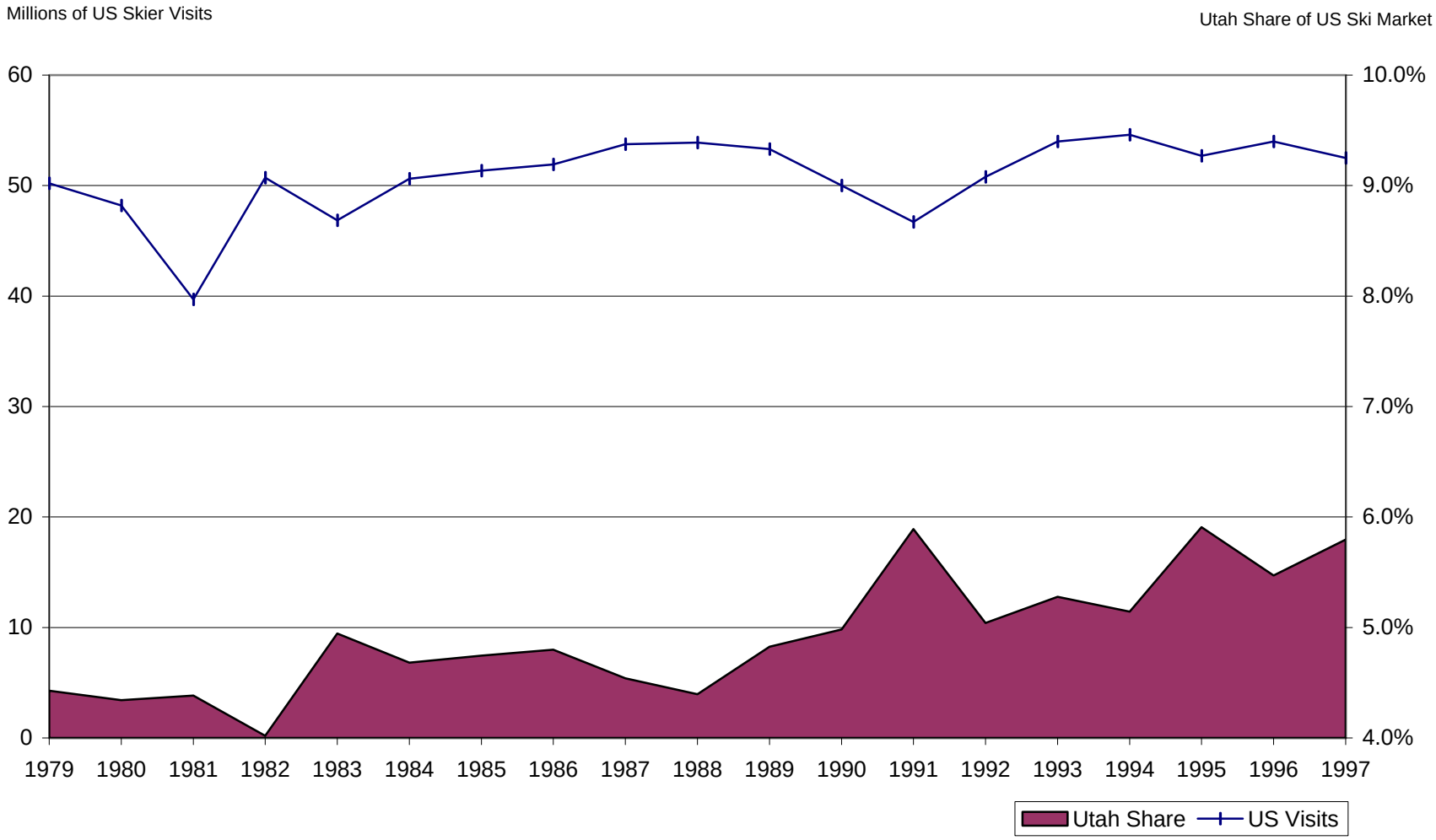


Figure 2
Utah Skier Visits

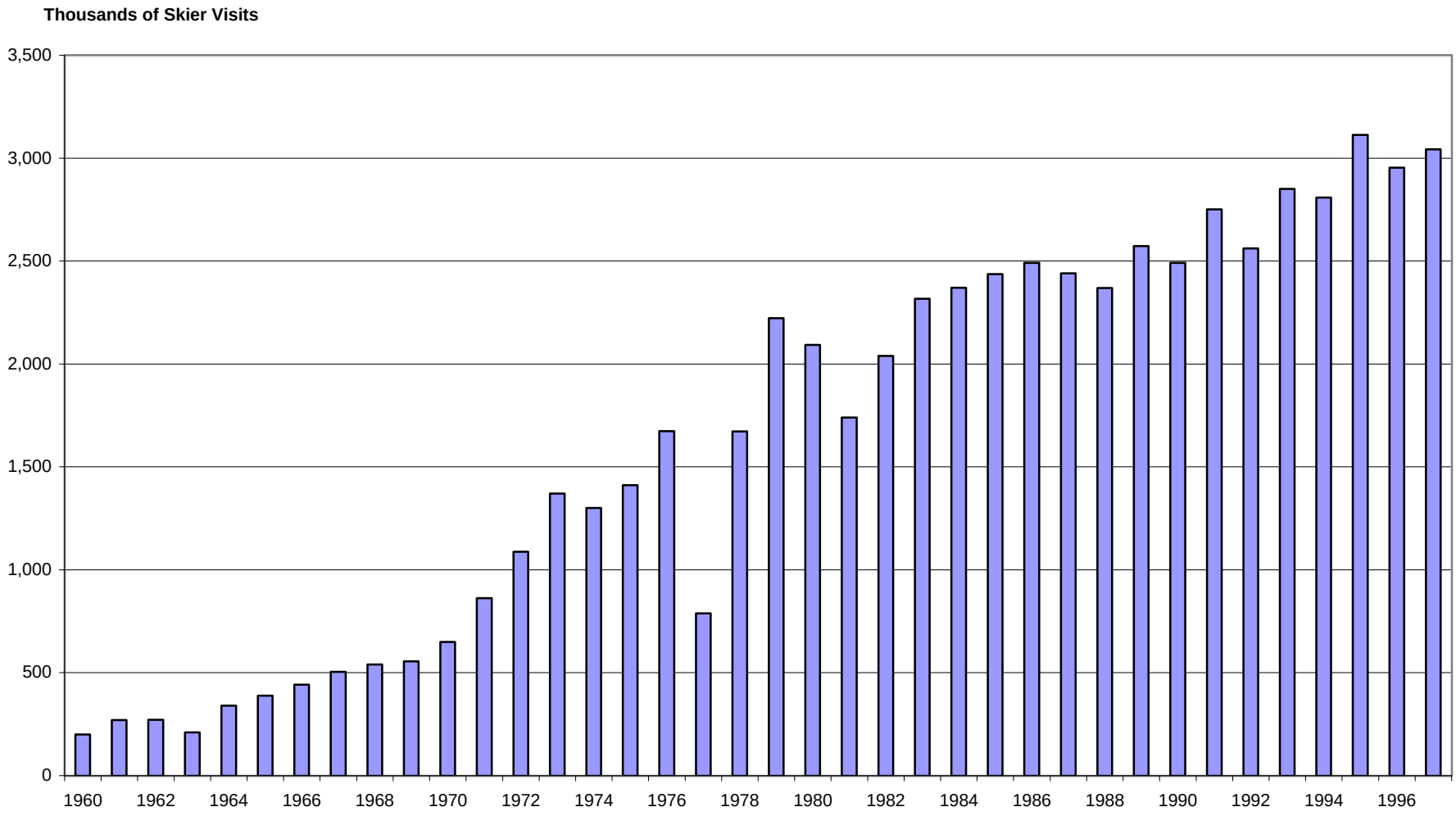


Figure 3
Estimated Resident and Destination Skier Visits in Utah

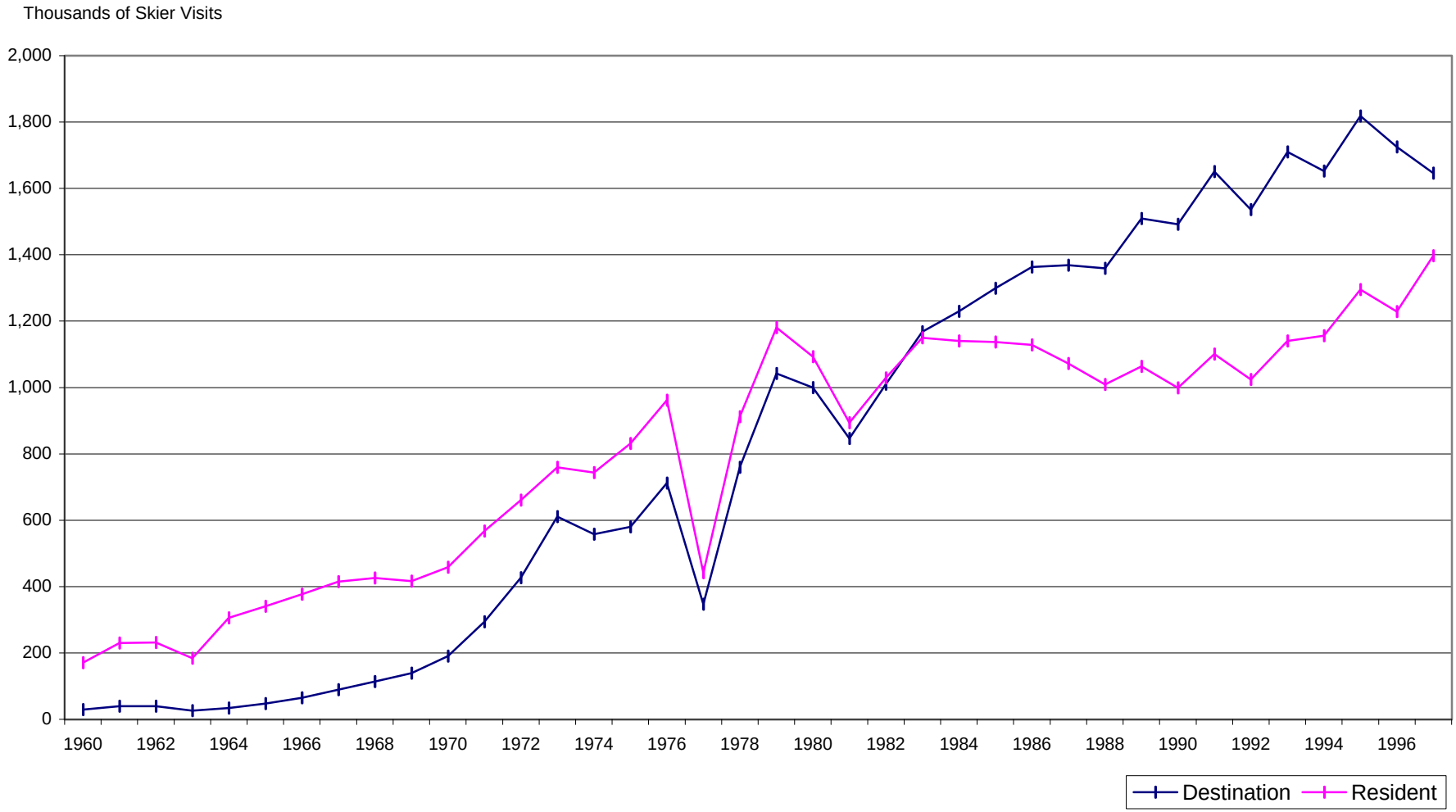


Figure 4

Resident Skier Visits and the Utah Skiing Age Population

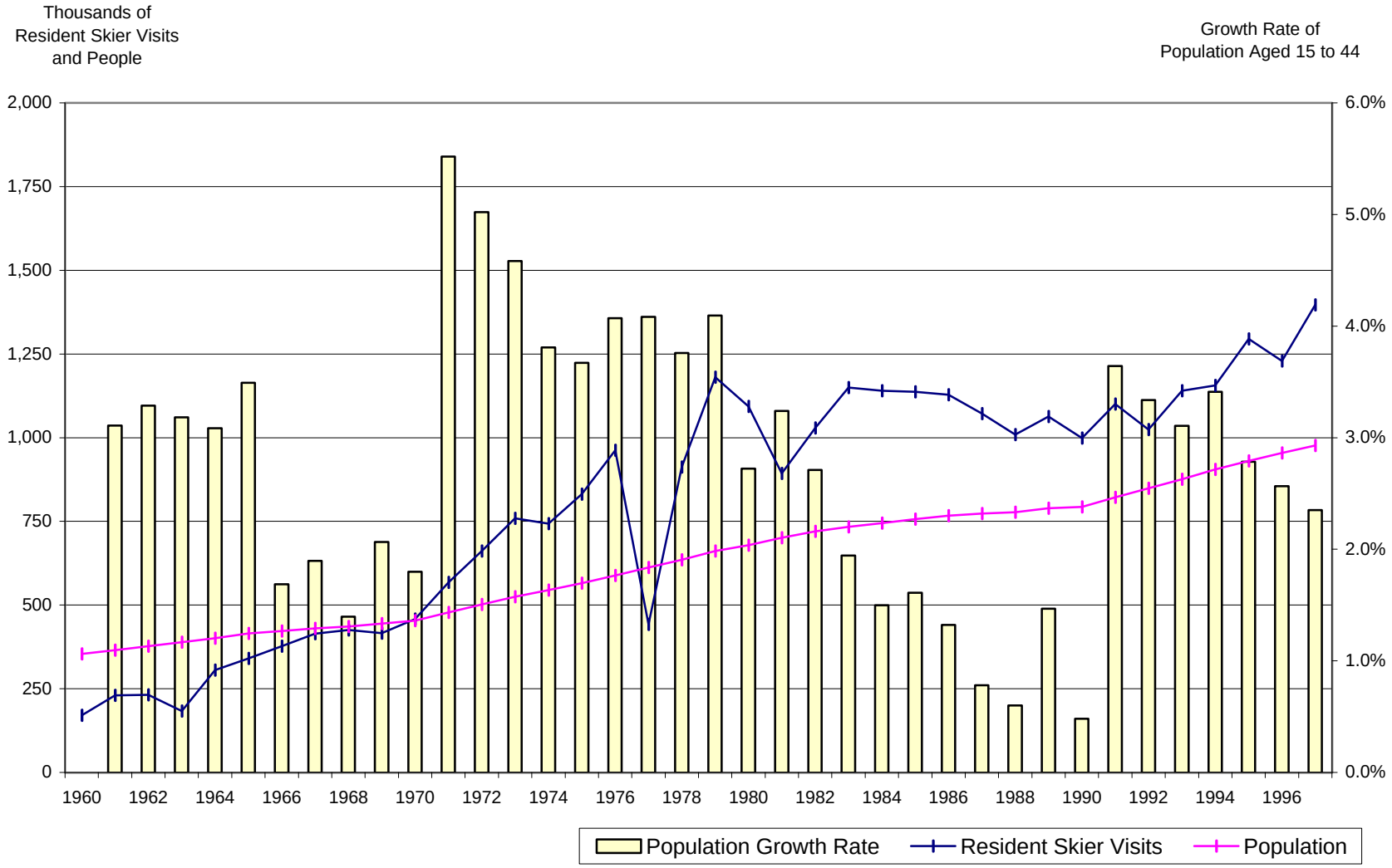


Figure 5

Utah Skiing Age Population

Number and Growth Rate of People in 15 to 44 Age Group

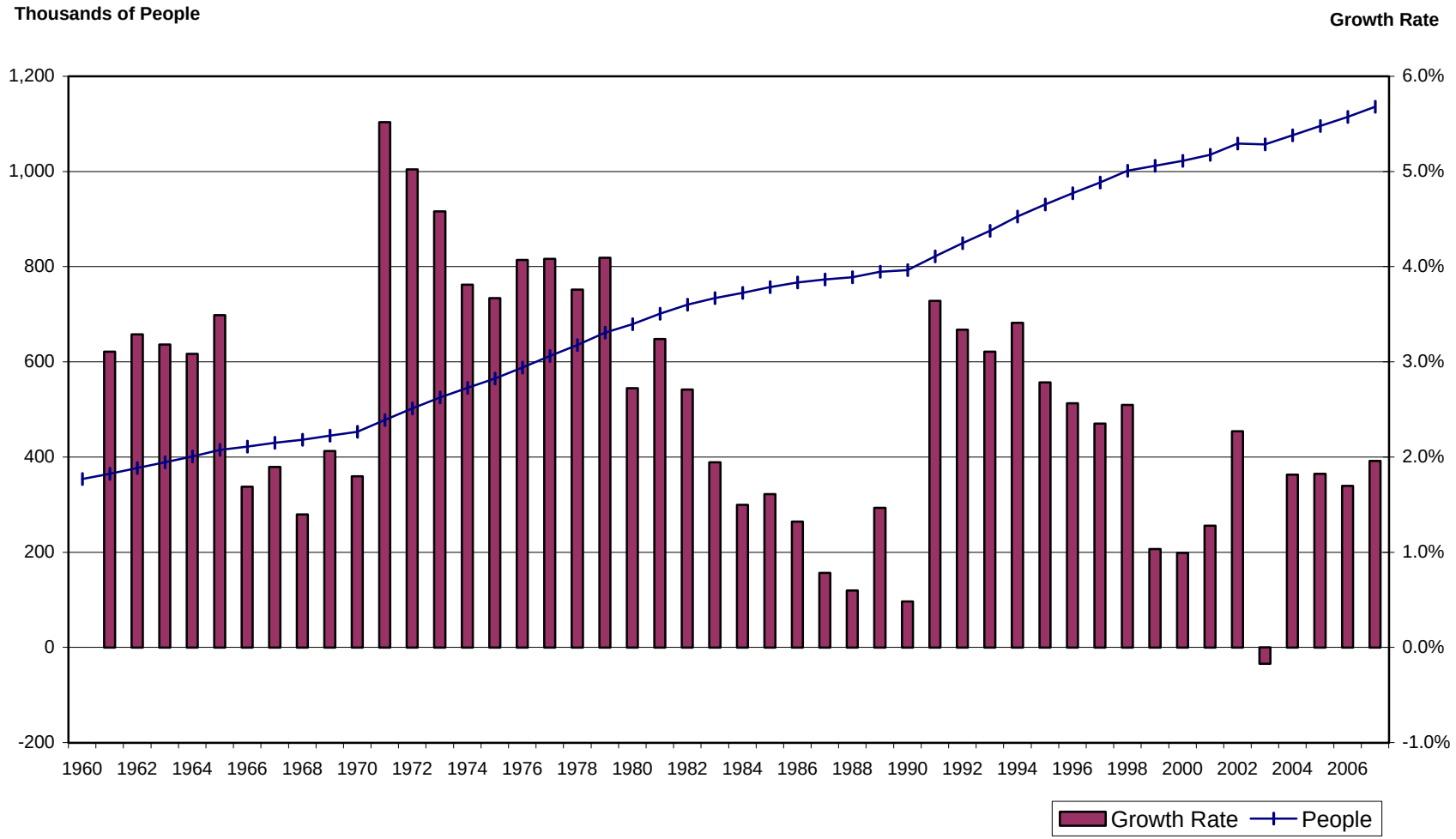


Figure 6

U.S. Skiing Age Population

Number and Growth Rate of People in 15 to 54 Age Group

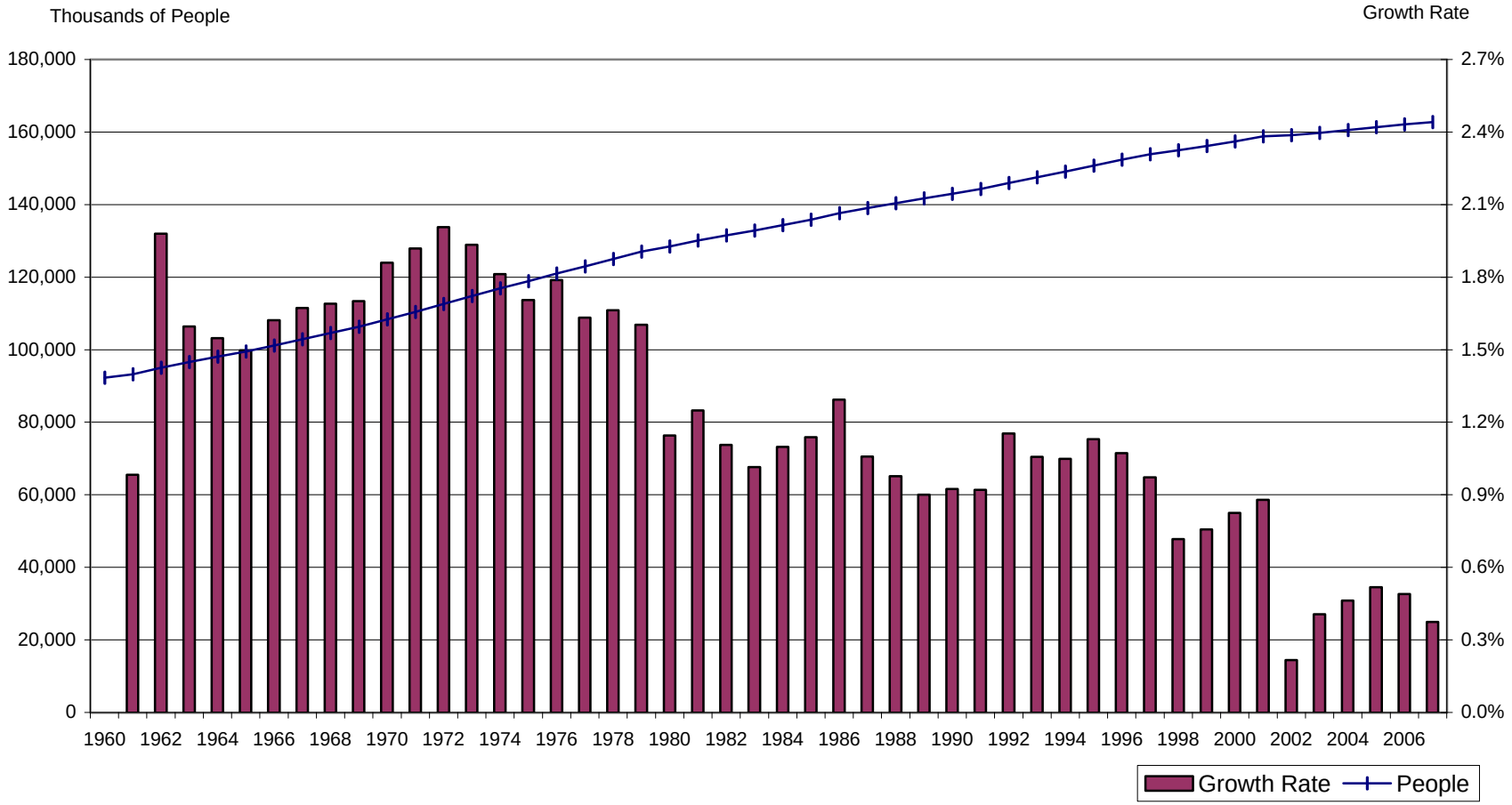


Figure 7

A Comparison of Skier Visits in Utah and the US with US Skiing Age Population

Indexing Skier Visits and US Population Aged 15 to 54 so 1979 Level is 1

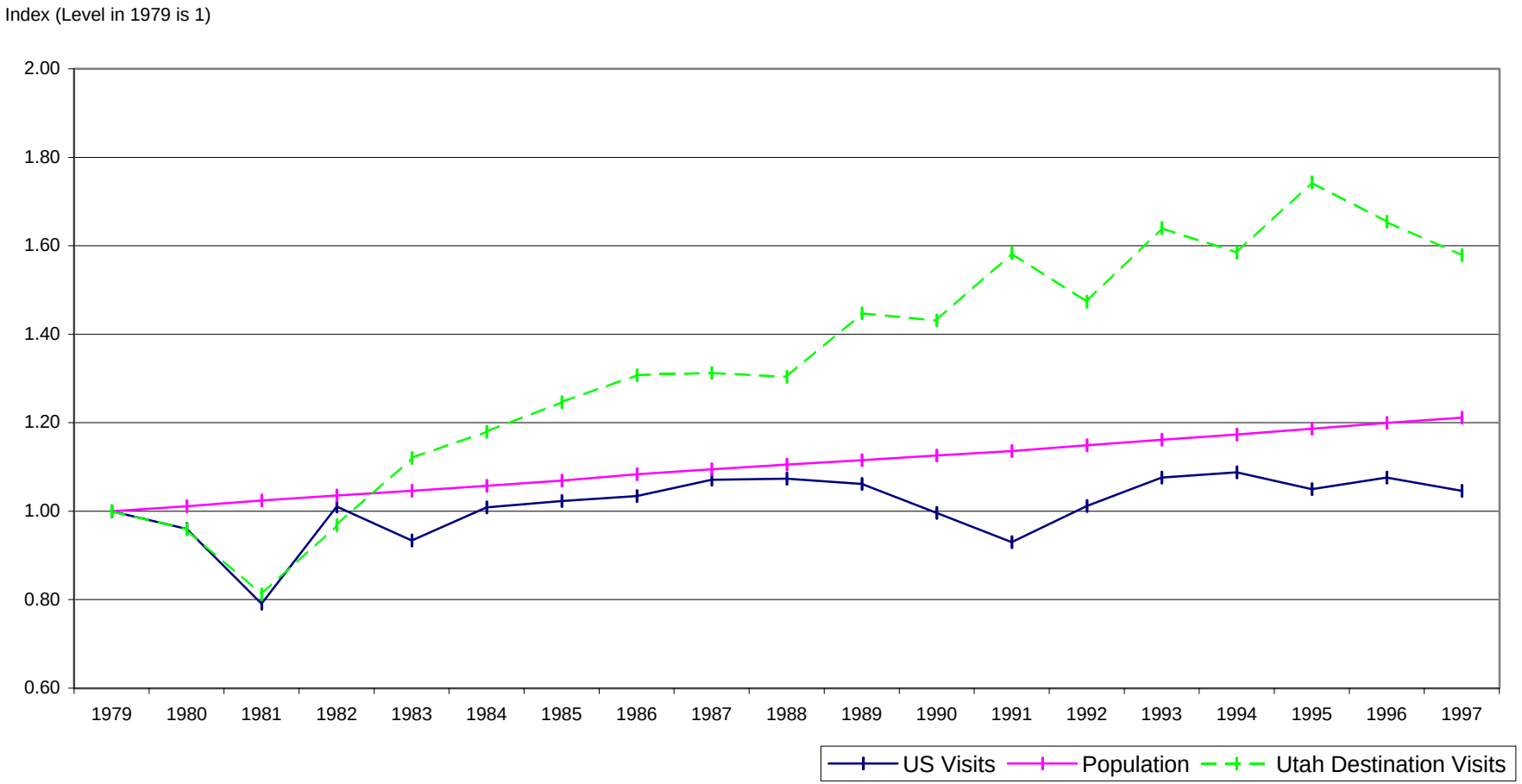


Figure 8

Utah Skier Visits and Ski Lift Capacity

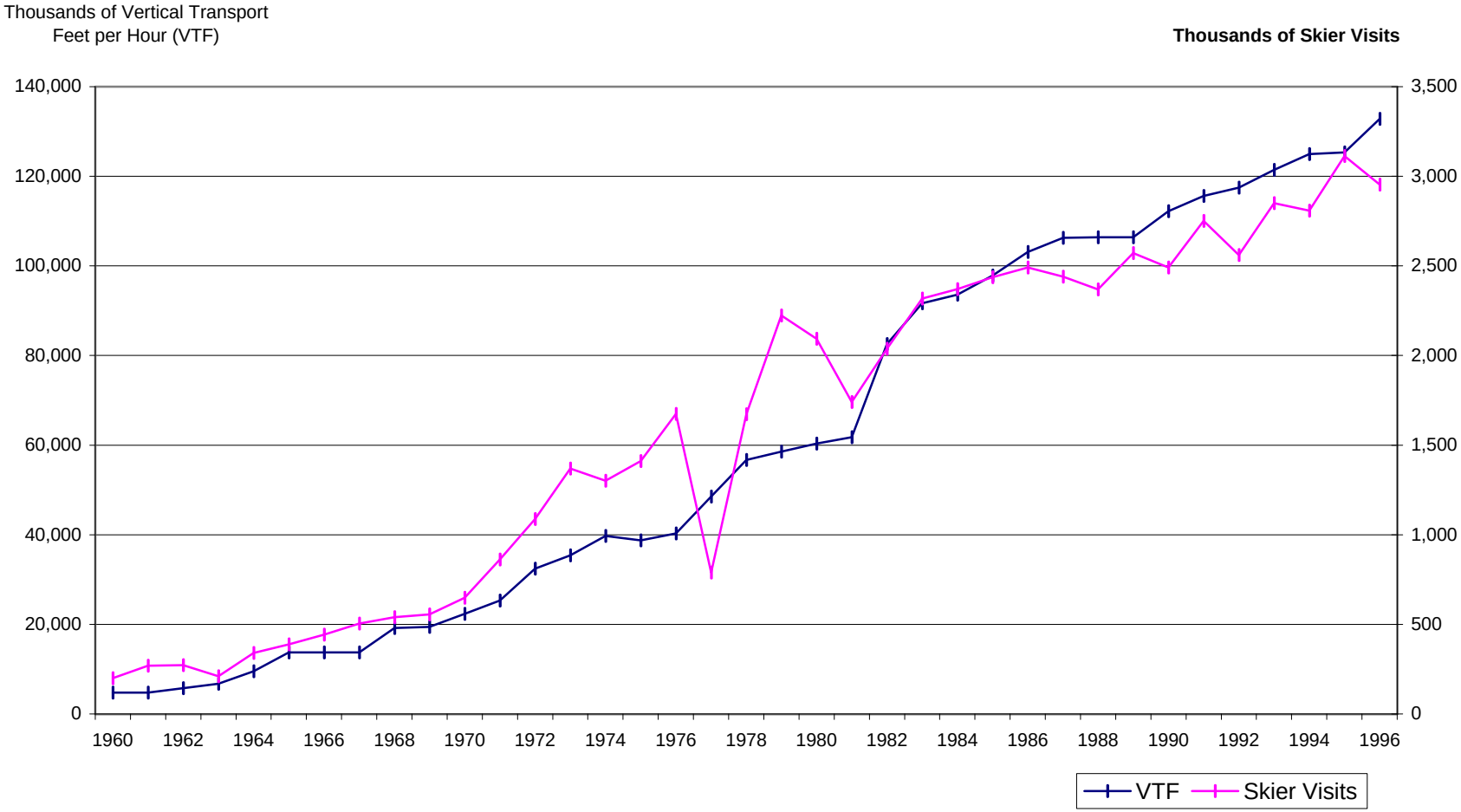


Figure 9

Utah Skier Visits and Snow Conditions

Visits Measured Against the Number of Days Brighton Reports over 40 Inches of Snow

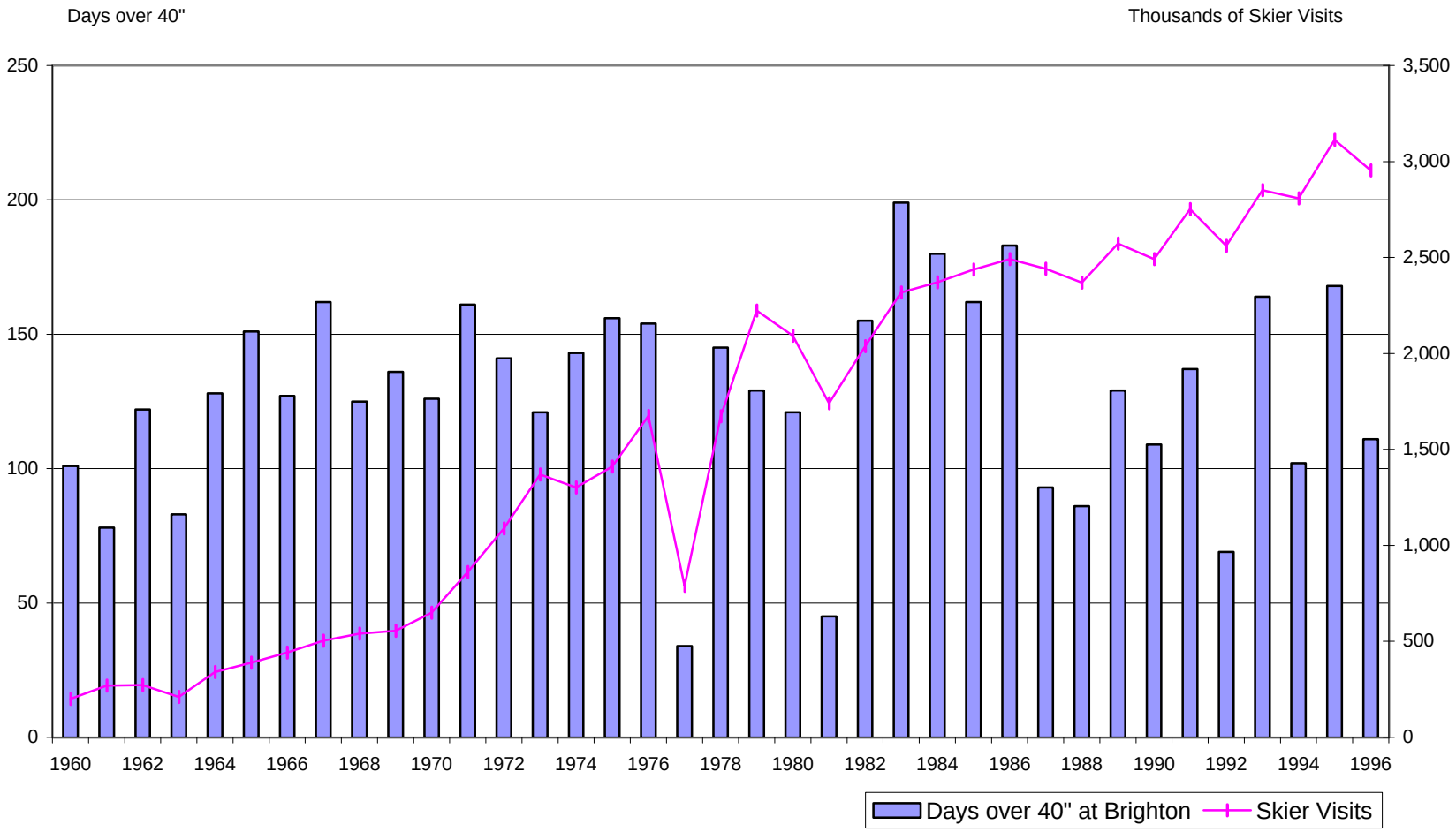


Figure 10

Snowmaking at Utah Ski Resorts

Acres of Snowmaking

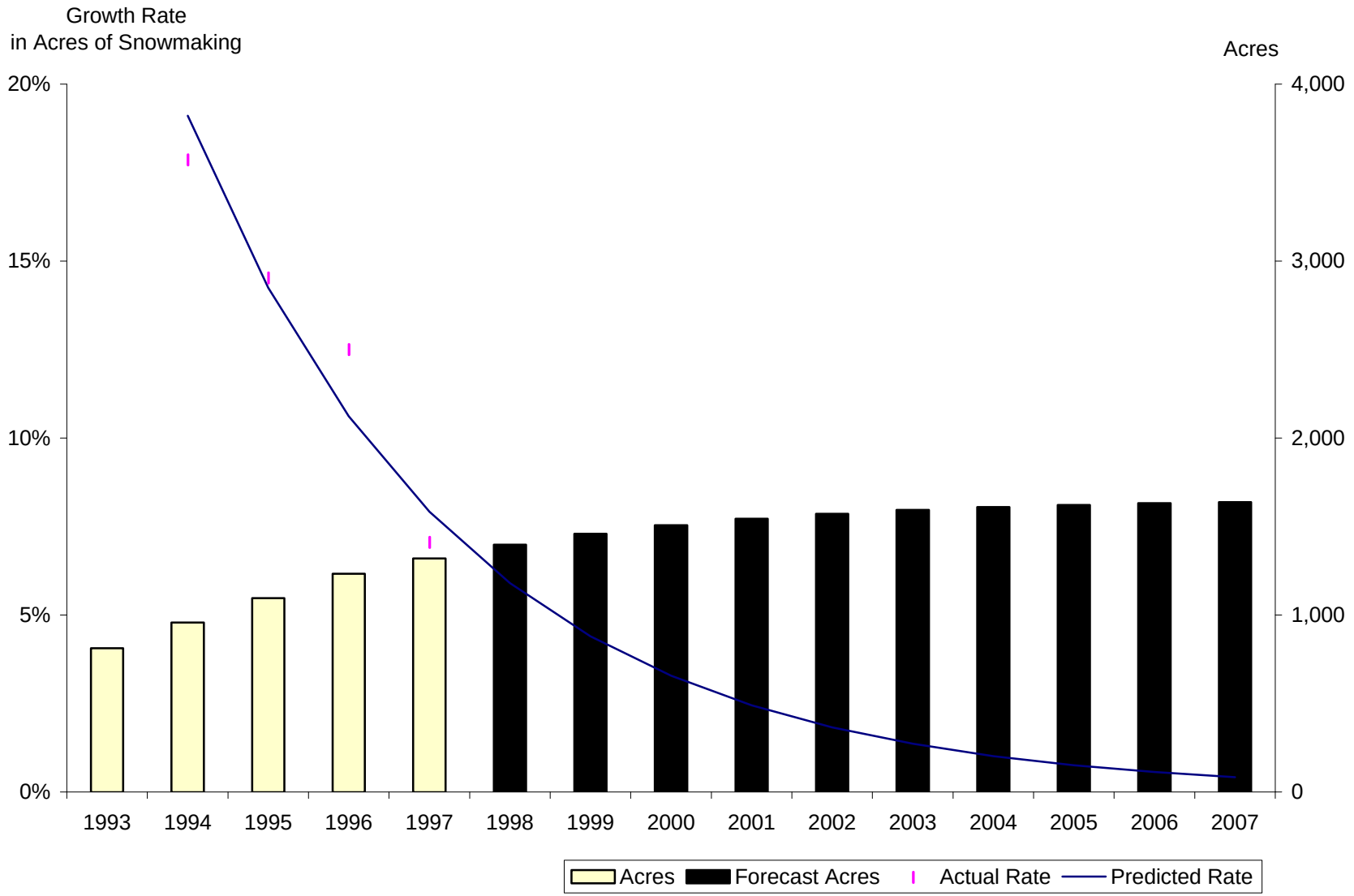


Figure 11

Number of Days with over 40 inches of Snow at Brighton

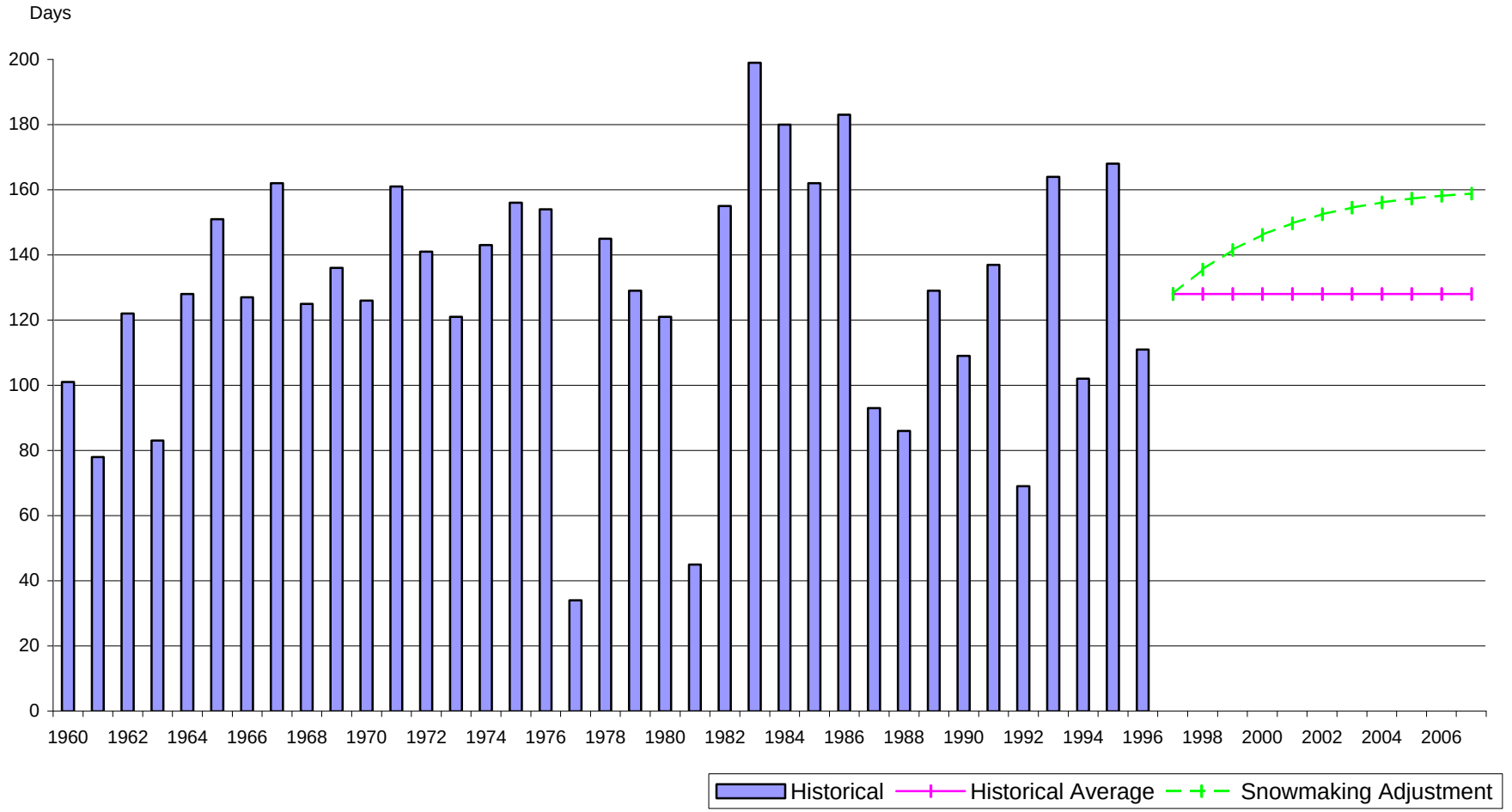


Figure 12
Proposed Action
Distribution of Skier Visits by Resort Group: 1996 and 2007

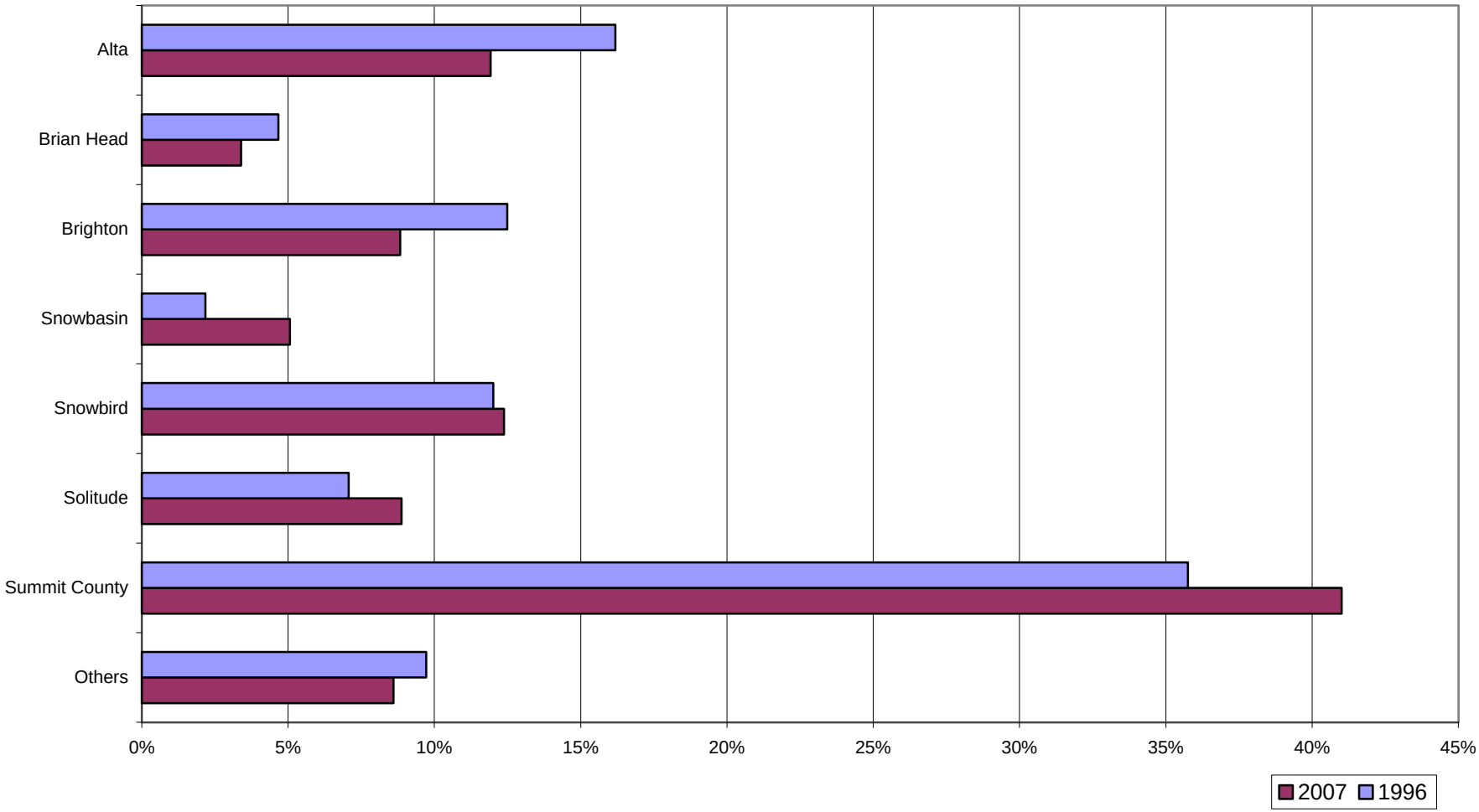
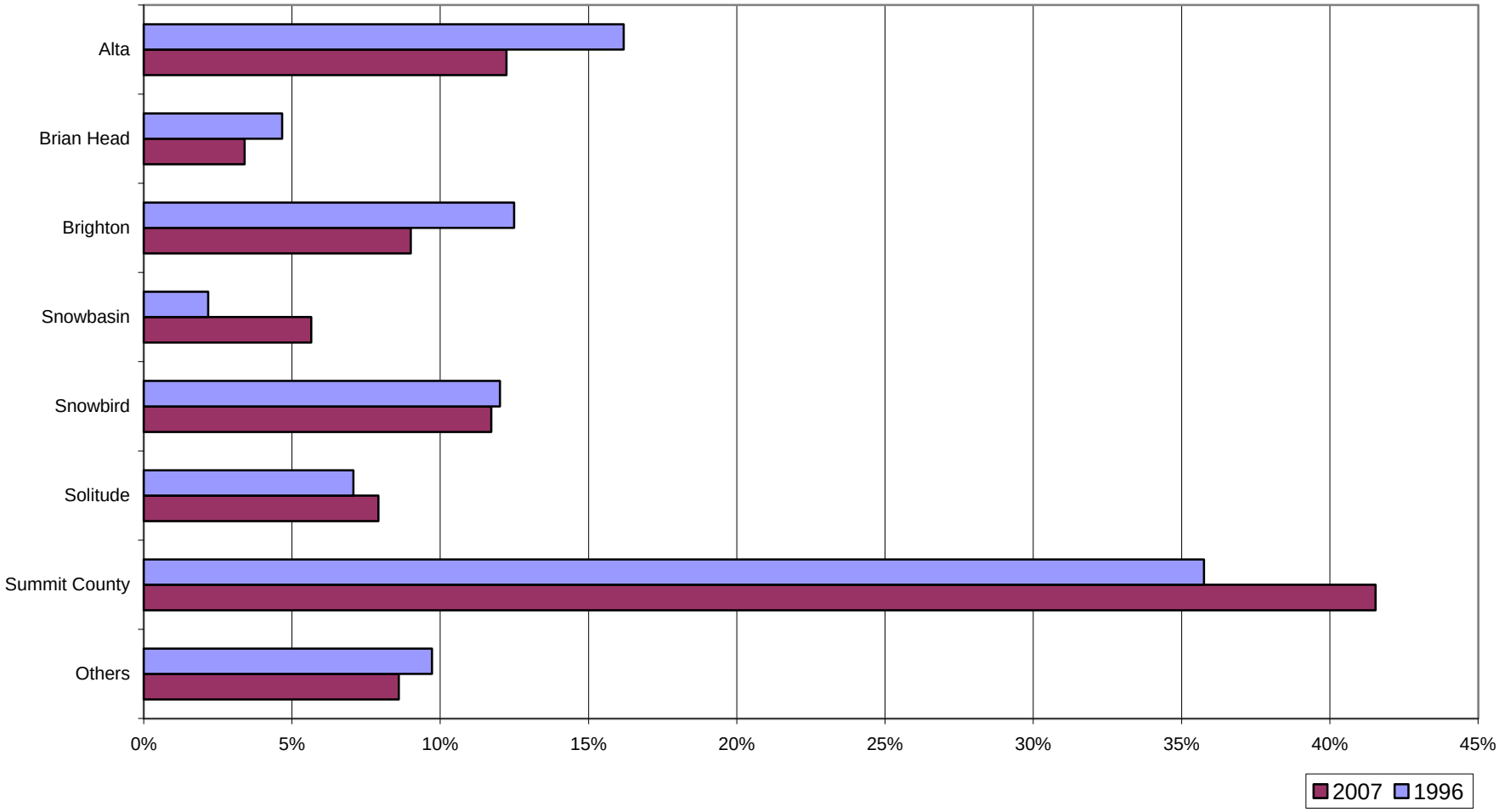


Figure 13
No Action
Distribution of Skier Visits by Resort Group: 1996 and 2007



Appendix I

Accuracy of Past Skier Visit Projections

Introduction

The Governor's Office of Planning and Budget has published projections of Utah skier visits in two previous studies. These include projections for the 1989 Salt Lake County Wasatch-Canyons Master Plan and the 1991 Brighton Ski Area Master Plan Environmental Impact Statement.[1] In addition to these state-produced projections, the U.S. Forest Service projected ski activity for the 1985 Wasatch-Cache National Forest Land and Resource Plan. While these Forest Service projections were oriented towards a different measure of ski activity (skiers at one time), they provide an interesting context for evaluating the accuracy of the projections prepared by the Governor's Office of Planning and Budget. This analysis, then, compares the skier visit projections from these three different studies to actual skier visits. Mean absolute percentage errors are calculated for the first eight years of each projection interval, the entire interval, and for an interval that excludes the years when snow conditions deviated significantly from the average. Findings and recommendations for improving future skier visit projections are also suggested.

Accuracy

Comparing the accuracy of skier visit projections that originate from separate methodologies, include different starting points, and, consequently, extend for varying lengths of time is troublesome. Comparisons are further complicated by the importance of snow conditions in any given year. The intent here is to discover whether the models developed by the Governor's Office of Planning and Budget have resulted in a more accurate depiction of future skier visits. Related to this is the need to determine where the Governor's Office of Planning and Budget ought to place additional resources to improve future skier visit projections.

The accuracy of skier visit projections is quantified here by organizing actual and projected skier visits from three separate studies; calculating mean absolute percentage errors (MAPEs)[2]; and adjusting the measures for years when snow conditions deviate significantly from the average year. The source of and brief methodology for producing skier visit projections are described first, followed by the

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[1] Skier visit projections were also included in the 1994 update of the *Utah Ski Database*, but these projections were so recent that there are too few years of projections to accurately ascertain the accuracy. Consequently, analysis of these projections are not included in this Appendix.

[2] Mean absolute percentage errors are used so that negative and positive errors won't cancel each other out. They are calculated by (1) taking the absolute value of the actual value less the projected value; and, (2) dividing this difference by the actual value to derive the percentage error.

actual errors. Errors are measured for three different series of projection intervals:

1. **Average Error for First Eight Years** – This is the mean absolute percentage error for the first eight years of the projection interval. Since each series of projections begins in a different year, the MAPEs are not calculated for the same group of years. However, this is perhaps the best measure of accuracy since the errors are calculated for an equal number of years and for years that are the same length of time from the starting point.

2. **Average Error for the Entire Interval** – This is the mean absolute percentage error for the entire projection interval that can be compared to actual data. This interval is the longest for the projections used in the Wasatch-Cache National Forest Land and Resource Management Plan (13 years); followed by the Salt Lake County Wasatch-Canyon Master Plan (10 years) and Brighton Ski Area Master Plan Environmental Impact Statement (8 years). These errors are provided to simply portray the magnitude of error for the longest series of years possible.

3. **Average Error for the Entire Interval Adjusted for Snow Conditions** – This is the mean absolute percentage error for the entire projection interval except that snow years that deviate significantly from an average year are excluded. There are five of these years: 1985, 1986, 1992, 1993, and 1995. This measure is useful because it can be compared to the unadjusted measure to show whether a method's accuracy improves when omitting bad snow years.

Comparisons

1985 Wasatch-Cache National Forest Land and Resource Management Plan – The Wasatch-Cache National Forest Plan included a range of projections for downhill skiing. Four approaches were utilized: (1) applying the downhill ski industry objective growth rate of 6%; (2) applying the expected population growth for the Wasatch Front metro area of 3.02%; (3) extrapolating historical use using a linear regression; and, (4) applying expected population growth of Utah, southeast Idaho, and southwest Wyoming. scenarios of skier growth. All of these were growth rate based and they ranged from a ___ growth rate that was based on ___ to a ___ growth rate that was called the industry objective. The most likely growth rate was deemed to be ___ and this rate was applied to 11th highest day skier visits for planning purposes. The analysis here extends this line of reasoning for illustrative purposes to the base year to derive skier visit tallies that can be compared to the work prepared by the Governor's Office of Planning and Budget.

The error in the Forest Plan projections are the highest for every measure. The MAPE for the first eight years equals 8.0%, and for the entire 13 year interval it

equals 9.4%. The Forest Plan projections are too high in every year. Interestingly, the error is even higher when adjusting for the years that snow conditions deviated significantly from the average. When the same methodology is applied to Big Cottonwood skier visits, the errors swell to over 40%.

1988 Salt Lake County Wasatch Canyon Master Plan – These projections included a major effort to organize a skier visit database that included as much history as possible. Data regarding ski age population, ski area capacity, lift ticket prices, snow conditions, and income were used to establish historical relationships between these variables and skier visits. Separate multiple regression equations were estimated for resident and destination skier visits.

The results are considerably better than those of the 1985 Forest Plan. The MAPE for the first eight years equals 5.1%, and for the entire ten-year projection interval it equals 5.2%. While there are no published standards of what magnitude of error is acceptable, as a general rule errors in the 3%-5% range are to be expected. In general, these projections were too low, although in some years they were too high. Interestingly, when adjusting for snow conditions the error over the entire projection interval drops to 4.4%. This is to be expected since projections are based on average snow conditions.

At the canyon-level the errors were much higher. Depending on the interval the MAPEs in Big Cottonwood Canyon ranged from 15%-18%. These are less than half the magnitude of error present in the 1985 Forest Plan projections, but are still too high.

1991 Brighton Master Plan Environmental Impact Statement – These projections utilized the previously organized skier visit database, but added three more years of historical data. Multiple regression techniques were once again used to project resident and destination skier visits separately. The capacity variable was eliminated from the equation structure. While capacity correlates strongly with skier visit growth, it is dubious to include it in applications such as this where decisions about ski area capacity are to be made. The largest modeling enhancement for this application was the development and calibration of a skier visit allocation gravity model. This model provided a more logical way to assign state control totals of skier visits to specific resorts.

The results of these improvements are encouraging. The MAPE for the first eight years and the entire projection interval (since they are the same interval) equals 2.8%. When adjusting for snow conditions the error drops to 1.5%. Further, the projections were too high in five of the years and too low in three of the years; this is a fairly reasonable distribution of the sign of the error.

Better still are the results at the canyon-level where the skier visit allocation gravity model was applied. The gravity model utilizes information about the

attractiveness of individual resorts and their distances from the population base (including residences for local skiers and hotel/motels for out-of-state skiers). The MAPE for the first eight years in Big Cottonwood Canyon equaled ___. When adjusting for snow these errors dropped to ___. These rates of error are three times less the comparable rates from the Salt Lake County Wasatch Canyon Master Plan and eight times less than the Wasatch-Cache Forest Plan. The development of the skier visit allocation gravity model has been the single most significant improvement.

Findings and Recommendations

This analysis of the accuracy of past skier visit projections is very instructive and helpful in determining where improvements need to be made for future skier visit projection work. The following are the most evident findings and recommendations:

1. Multiple regression forecasts that incorporate various determinants of ski demand and that are separated for resident and destination skier visits work better than just applying historical skier visit or population growth rates to the base year.

2. While ski area capacity (measured in terms of million of vertical transport feet) correlates significantly with skier visits, it is problematic when used as an independent variable in skier visit regression equations. The problem arises when skier visit projections are being used to render judgements regarding the need for expanding capacity. While the Governor's Office of Planning and Budget will continue to monitor capacity growth in the Utah ski industry it will not be used as a variable to project future skier visits.

3. Snow conditions impact skier visits dramatically and improvements to the snow variable should be considered. Of particular interest is the growth in snowmaking. __ of Utah's __ resorts make snow in varying quantities. This has the effect of reducing the risk that resorts face each year from weather conditions. Over time snowmaking will result in a more predictable pattern of skier visits becuase the season length will be more constant.

4. The skier visit allocation gravity model is a very valuable planning tool. It provides a reasonable and defendable allocation of skier visits and can be used to address scenarios. Potential improvements to the gravity model include expanding it to include the entire state and adding and ammenity value in calibrating resort attractiveness.

5. This analysis of the accuracy of skier visit projections did not generate any surprises. In general the analysis showed that:

    - More elaborate and detailed models improved the projections;
    - More historical data improves the accuracy;

- Small area projections generate higher error;
- Accounting for snow conditions improves accuracy; and,
- The shorter the projection interval the smaller the error.

Comparison of Actual Skier Visits with Projected Skier Visits

Skier Visits in Thousands

Februrary 6, 1998

	Actual	W-C Forest Plan 1985	Num. Diff.	% Diff.	Abs. Value % Error	CMP 1989	Num. Diff.	% Diff.	Abs. Value % Error	Brighton EIS 1991	Num. Diff.	% Diff.	Abs. Value % Error
1984	2,370	2,370				2,370				2,370			
1985	2,437	2,442	5	0.21%	0.21%	2,437				2,437			
1986	2,491	2,515	24	0.97%	0.97%	2,491				2,491			
1987	2,441	2,591	151	6.17%	6.17%	2,441				2,441			
1988	2,369	2,670	301	12.69%	12.69%	2,468	99	4.18%	4.18%	2,369			
1989	2,572	2,750	178	6.92%	6.92%	2,436	(136)	-5.29%	5.29%	2,572			
1990	2,491	2,833	342	13.73%	13.73%	2,483	(8)	-0.33%	0.33%	2,500	9	0.35%	0.35%
1991	2,752	2,919	167	6.08%	6.08%	2,584	(168)	-6.09%	6.09%	2,643	(109)	-3.95%	3.95%
1992	2,561	3,007	446	17.42%	17.42%	2,620	59	2.31%	2.31%	2,723	162	6.33%	6.33%
1993	2,850	3,098	248	8.69%	8.69%	2,663	(187)	-6.56%	6.56%	2,788	(62)	-2.18%	2.18%
1994	2,800	3,191	391	13.97%	13.97%	2,686	(114)	-4.07%	4.07%	2,852	52	1.86%	1.86%
1995	3,114	3,288	174	5.58%	5.58%	2,736	(378)	-12.14%	12.14%	2,921	(193)	-6.20%	6.20%
1996	2,954	3,387	433	14.66%	14.66%	2,799	(155)	-5.25%	5.25%	2,988	34	1.15%	1.15%
1997	3,043	3,489	446	14.66%	14.66%	2,870	(173)	-5.69%	5.69%	3,056	13	0.43%	0.43%
Avg. Over First Eight Year Interval			202	8.0%	8.0%		(104)	-3.5%	5.1%		(12)	-0.3%	2.8%
Avg. Over Entire Interval (# of yrs. varies)			254	9.4%	9.4%		(116)	-3.9%	5.2%		(12)	-0.3%	2.8%
Avg. Over Entire Interval Adj. for Snow			301	11.1%	11.1%		(94)	-3.2%	4.4%		(0)	-0.0%	1.5%

Notes:

1. Shaded areas denote projection intervals
2. The average over the first eight year interval is useful in comparing the accuracy of the first eight years of each projection. Since each of the projections started in different years, this comparison compares different intervals but for the same length of time.
3. The average over the entire interval measures accuracy since the launch year of the projections. The number of years in each of these intervals varies.
4. The average over the interval adjusted for snow simply omits the projected values for years when the snow conditions (as measured by estimated season length) deviated significantly from the average. These years are 1985, 1986, 1992, 1993, and 1995.
5. W-C Forest Plan = 1985 Wasatch-Cache National Forest Land and Resource Management Plan; CMP = 1988 Salt Lake County Wasatch-Canyon Master Plan; Brighton EIS = 1991 Brighton Ski Area Master Plan Environmental Impact Statement

Comparison of Actual Skier Visits with Projected Skier Visits — Big Cottonwood

Skier Visits in Thousands

Februrary 6, 1998

	Actual	W-C Forest Plan 1985	Num. Diff.	% Diff.	Abs. Value % Error	CMP 1989	Num. Diff.	% Diff.	Abs. Value % Error	Brighton I 1991	Num. Diff.	% Diff.	Abs. Value % Error
1984	208	208								208			
1985	393	214	(179)	-45.5%	45.5%	393				393			
1986	468	221	(247)	-52.8%	52.8%	468				468			
1987	435	227	(207)	-47.7%	47.7%	435				435			
1988	387	234	(152)	-39.4%	39.4%	422	36	9.2%	9.2%	387			
1989	388	241	(147)	-37.8%	37.8%	489	101	26.1%	26.1%	388			
1990	393	249	(144)	-36.7%	36.7%	495	103	26.1%	26.1%	410	17	4.4%	4.4%
1991	420	256	(163)	-38.9%	38.9%	550	131	31.2%	31.2%	421	2	0.4%	0.4%
1992	441	264	(177)	-40.2%	40.2%	555	114	25.7%	25.7%	479	38	8.6%	8.6%
1993	496	272	(224)	-45.2%	45.2%	565	69	14.0%	14.0%	492	(4)	-0.8%	0.8%
1994	543	280	(263)	-48.4%	48.4%	567	24	4.5%	4.5%	506	(37)	-6.8%	6.8%
1995	613	289	(324)	-52.9%	52.9%	578	(35)	-5.7%	5.7%	539	(74)	-12.1%	12.1%
1996	577	297	(280)	-48.5%	48.5%	587	9	1.6%	1.6%	553	(24)	-4.2%	4.2%
1997	573	306	(267)	-46.5%	46.5%	594	21	3.7%	3.7%	566	(7)	-1.2%	1.2%
Avg. Over First Eight Year Interval			(177)	-42.4%	42.4%		68	16.4%	17.8%		(11)	-1.5%	4.8%
Avg. Over Entire Interval (# of yrs. varies)			(213)	-44.7%	44.7%		57	13.6%	14.8%		(11)	-1.5%	4.8%
Avg. Over Entire Interval Adj. for Snow			(203)	-43.0%	43.0%		61	14.6%	14.6%		(10)	-1.5%	3.4%

Notes:

1. Shaded areas denote projection intervals
2. The average over the first eight year interval is useful in comparing the accuracy of the first eight years of each projection. Since each of the projections started in different years, this comparison compares different intervals but for the same length of time.
3. The average over the entire interval measures accuracy since the launch year of the projections. The number of years in each of these intervals varies.
4. The average over the interval adjusted for snow simply omits the projected values for years when the snow conditions (as measured by estimated season length) deviated significantly from the average. These years are 1985, 1986, 1992, 1993, and 1995.
5. W-C Forest Plan = 1985 Wasatch-Cache National Forest Land and Resource Management Plan; CMP = 1988 Salt Lake County Wasatch-Canyon Master Plan; Brighton EIS = 1991 Brighton Ski Area Master Plan Environmental Impact Statement

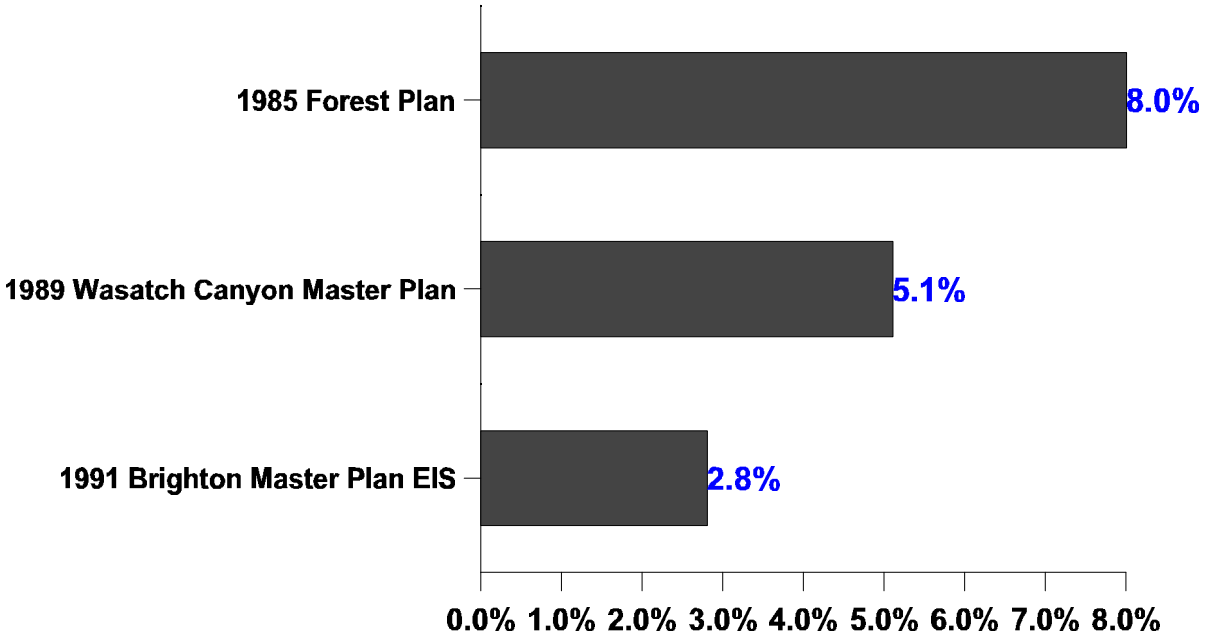
Comparison of Actual Skier Visits with Projected Skier Visits — Little Cottonwood

Februrary 11, 1997

	Actual	W-C Fores Plan 1985	Num. Diff.	% Diff.	Abs. Valu % Error	CMP 1988	Num. Diff.	% Diff.	Abs. Valu % Error
1984	784	784							
1985	770	808	38	4.96%	4.96%	770			
1986	783	832	49	6.28%	6.28%	783			
1987	887	857	(29)	-3.31%	3.31%	887	0	0.00%	0.00%
1988	721	883	162	22.45%	22.45%	923	202	27.94%	27.94%
1989	817	910	93	11.34%	11.34%	863	46	5.57%	5.57%
1990	865	937	72	8.33%	8.33%	880	15	1.76%	1.76%
1991	905	966	61	6.70%	6.70%	886	(19)	-2.04%	2.04%
1992	898	995	97	10.76%	10.76%	905	7	0.75%	0.75%
1993	864	1,025	160	18.55%	18.55%	926	62	7.14%	7.14%
1994	830	1,056	225	27.16%	27.16%	937	107	12.88%	12.88%
1995	885	1,088	203	22.89%	22.89%	976	91	10.27%	10.27%
1996	832	1,120	288	34.62%	34.62%	1,003	171	20.53%	20.53%
1997	838	1,154	317	37.80%	37.80%	1,042	204	24.41%	24.41%
Avg. Over Interval			118	14.23%	14.78%		68	8.48%	8.89%
Avg. Over Interval Adj. for Snow			124	15.33%	16.27%		74	9.52%	10.10%

Comparison of Actual and Projected Statewide Skier Visits

Mean Absolute Percentage Errors Over First 8-Year Interval



Comparison of Actual and Projected Statewide Skier Visits

Mean Absolute Percentage Errors Over Entire Interval